

MODEL RS-680
TIMING SIMULATOR/WORD GENERATOR
USER'S MANUAL

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November 1, 1981

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Warranty: Interface Technology warrants each instrument to be free of defects in material and workmanship for a period of one (1) year from the date of shipment to the original purchaser. Interface Technology will service, replace or adjust any defective part or parts, free of charge, when the instrument is returned to Interface Technology FREIGHT PREPAID. When examination reveals that a fault has not occurred because of misuse or abnormal conditions or operation, Interface Technology will return the instrument PREPAID BY NORMAL CARRIER (to be determined by Interface Technology). Special requests will be shipped C.O.D.

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Boards sent in for repair will be subject to a \$75.00 service charge. This charge includes 2 hours of troubleshooting time. Any time above the 2 hours will be charged at the rate of \$52.00 per hour. Non-warranty board exchange will be made for \$75.00 with return of the defective board. If the defective board is not returned, then the customer will be billed for the cost of the board. The customer is responsible for ALL SHIPPING CHARGES.

Foreign Repairs: All foreign shipments are made C.O.D. For units under warranty, we will provide parts needed to repair the unit free of charge. Replaced parts should not be returned to Interface unless requested. For non-warranty repairs, the replacement parts will be billed. For units being returned to the United States, arrangements should be made prior to returning the unit.

PERSONAL SAFETY

The equipment described in this manual contains voltages hazardous to human life and safety and which are capable of inflicting personal injury.

For all procedures involving component insertion or withdrawal, the equipment must be powered off to prevent component damage. It is also recommended for such procedures that the primary power cord be disconnected from the equipment's rear panel connector to prevent accidental contact with primary power circuits. While physical measures have been built into the equipment to prevent accidental contact with high voltages during maintenance and troubleshooting procedures, the user should still exercise caution. Careless probing inside the equipment may result in the exposure of high voltage terminals.

Before operating the unit, ensure that the primary power outlet includes a functional protective ground (earth) circuit. Do not defeat the unit's internal protective ground circuit to chassis by using a two conductor adapter plug or other such device.

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ERRATA

Page 4-19, TABLE 4-2

ADDED: Note: When executing the remote command "Load Word Generator Data" via the RS-232C interface, it may be necessary to insert delays between data words to insure against the lost of data. The delay requirement is dependant upon the interface baud rate and the RS-680 channel configuration as tabulated below:

<u>INTERFACE</u>	<u>RS-680 CHANNEL CONFIGURATION</u>					
<u>Baud Rate</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>8</u>	<u>16</u>
110	Ø	Ø	Ø	Ø	Ø	Ø
150	Ø	Ø	Ø	Ø	Ø	Ø
300	19 MS	Ø	Ø	Ø	Ø	Ø
600	53 MS	11 MS	Ø	Ø	Ø	Ø
1200	72 MS	29 MS	3 MS	Ø	Ø	Ø
2400	80 MS	38 MS	12 MS	Ø	Ø	Ø
4800	85 MS	42 MS	17 MS	Ø	Ø	Ø
9600	87 MS	45 MS	19 MS	Ø	Ø	Ø

The form for this command then should be: Wc, aaaa, dddd, delay dddd,
delay dddd, ..., delay dddd,

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I. INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model RS-680 Word Generator/Timing Simulator is a 16 channel, general purpose digital signal generator. The unit is capable of operating at frequencies up to 100 MHz (10 nsec bit time) and incorporates the following key features:

Versatile operating modes; WORD GENERATOR or TIMING SIMULATOR

Simplified front panel operation.

C R T display for added operating convenience.

Fully controllable cursor.

Selectable data formats; hexadecimal or binary.

Single step, burst or continuous operation.

First bit and programmable sync outputs.

Gated output clocks.

External clock and trigger inputs.

External oscillator input for synchronous system operation.

Selectable ECL or TTL logic levels with front panel indicator.

Optional Plug-in stored program card.

Optional Remote control interfaces.

Optional rear panel I/O connector.

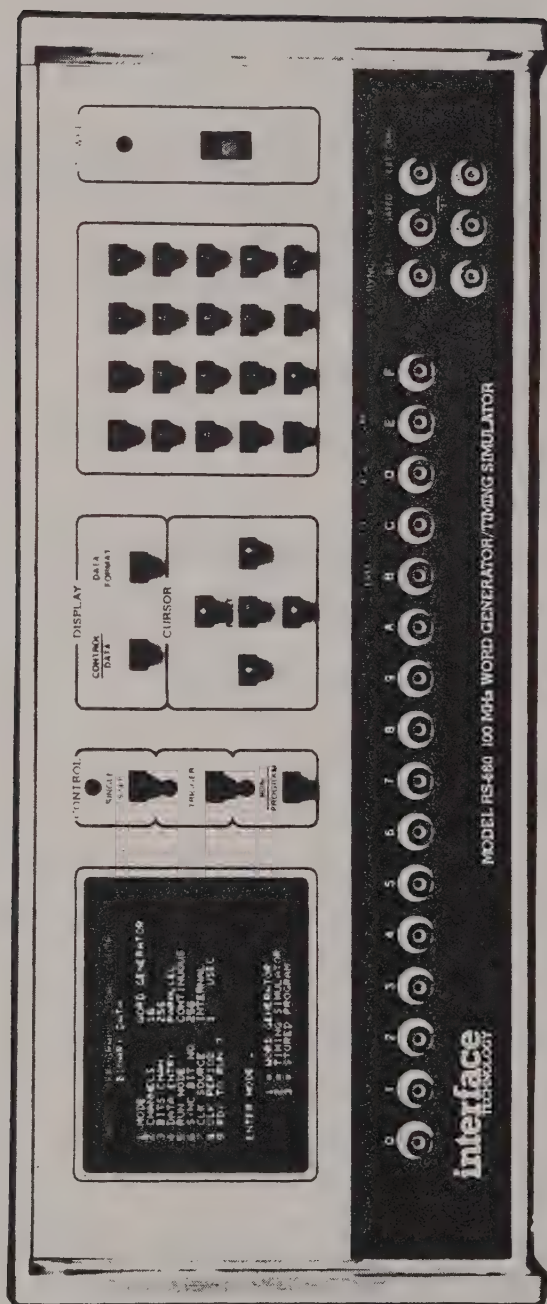
Figure 1.1 is a front view of the Model RS-680 and illustrates the front panel operating controls.

Figure 1.2 illustrates the unit's rear panel features, including the optional interface and I/O connectors.

1.2 OPTIONS

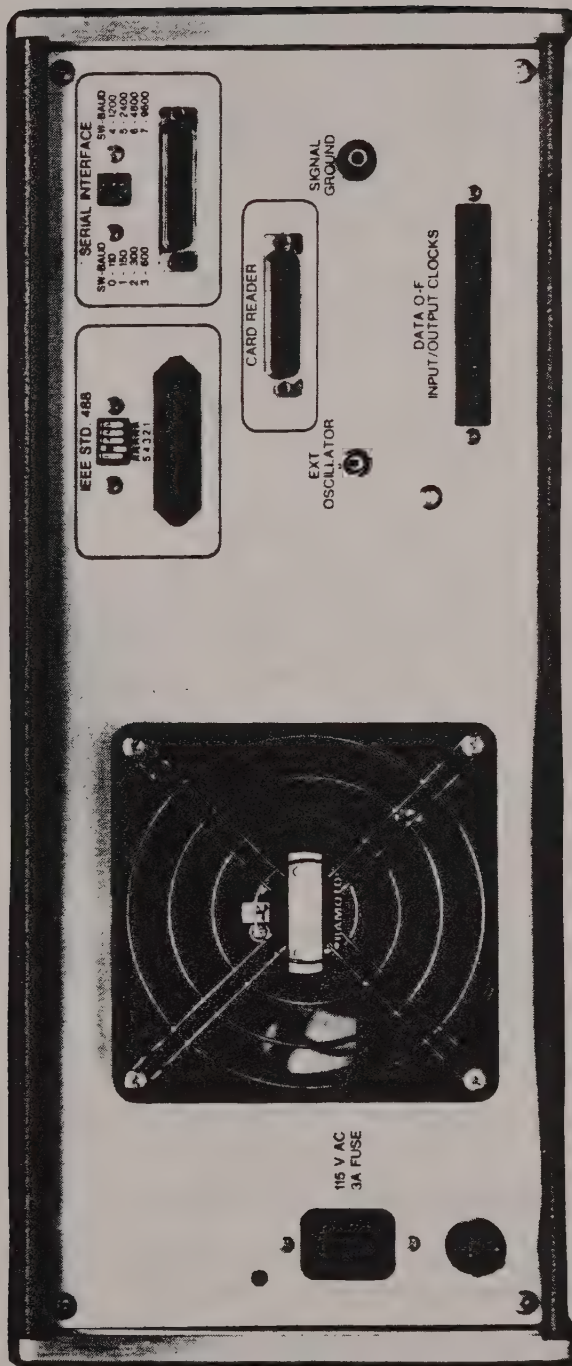
1.2.1 IEEE Std 488-1978 Control Interface (Option 680-001)

The optional IEEE Std 488-1978 control interface is a plug-in card which provides for remote control of the Model RS-680. The interface is capable of loading and reading the memory and control parameters, starting and stopping the unit and reading its status. Reference section 4.2.



MODEL RS-680 TIMING SIMULATOR/WORD GENERATOR

FIGURE 1.1



MODEL RS-680 REAR PANEL

FIGURE 1.2

1.2.2 RS/232C/TTY Control Interface (Option 680-002)

The RS-232C/TTY control interface is also an optional, plug-in card which provides for remote control of the Model RS-680, with the same capabilities as the IEEE Std. 488-1978 control interface. Reference section 4.3.

1.2.3 Card Reader Interface (Options 680-003 and 680-004)

Option 680-003 includes both a mark-sense card reader and the required interface. This enables the user to load frequently used programs into the Model RS-680 from mark-sense cards.

Option 680-004 comprises only the Model RS-680 card reader interface and may be used as a parallel eight bit interface for loading the instrument. Reference section 4.1.

1.2.4 Stored Program Card (Option 680-005)

The optional, plug-in stored program card enables the Model RS-680 to execute programs which have previously been stored in EPROMs. The card is capable of accommodating up to eight EPROMs which are not supplied and must be programmed externally.

Any of the following, 5 volt EPROM types may be used:

- | | |
|----------------------|------|
| a) Intel 2758 | 1Kx8 |
| b) Intel 2716 | 2Kx8 |
| c) Intel 2732 | 4Kx8 |
| d) Texas Instr. 2516 | 2Kx8 |

With Intel 2732 EPROMs installed, the card provides a maximum storage capacity of 24Kx8. Reference section 3.5 for a description of the stored program mode.

1.2.5 Rack-mount Adapter (Option 680-006)

This option allows the Model RS-680 to be mounted in a standard, 19 inch rack.

1.2.6 Additional Documentation Set (Option 680-007)

Additional copies of the instruction manual for the Model RS-680 may be ordered under option number 680-007.

1.2.7 Variable Output Level (Option 680-008)

To be supplied.

1.2.8

Rear Panel I/O Connector and Cable (Option 680-009)

A rear panel I/O connector and mating coaxial cable assembly are available under option number 680-009. The external cable assembly provides 3 feet of unterminated coaxial cable. The mating interface connector is an AMP 2-226651-5. The signal list is provided in Appendix A for this option.

The Model RS-680 may be operated in either of two distinct modes - Word Generator or Timing Simulator. The most convenient mode depends upon the specific application and must be selected prior to loading the instrument. While operating in the Word Generator mode each and every data word is output for the same length of time; i.e., the period of the clock source. This mode is therefore best suited to applications where data transitions occur at regular intervals. In the Timing Simulator mode each word of data may be output for a unique period of time. This enables the instrument to generate waveforms, containing pulses, of extremely short duration in the midst of long time intervals.

The Model RS-680 may be directed to either output a programmed data pattern from 1 to 4096 times upon receipt of a trigger, or to repeat the pattern continuously. This function is applicable to both Word Generator and Timing Simulator modes.

Data may be loaded using either binary or hexadecimal. When dealing with waveforms it is usually more convenient to use binary, whereas data transfers are sometimes more conveniently dealt with using hexadecimal.

1.3.1 Application of the Word Generator Mode

Assuming that the desired output waveform has been examined and the Word Generator mode of operation has been selected as being the most appropriate, the next step entails selecting the number of data channels to be used and determining the period of the clock source. The clock period may be defined as the shortest time interval between any data level transitions on any channel. Having defined the clock period, the desired output waveform should be divided into time intervals, each being equal to one clock period. The number of bits per channel may now be defined and is equal to the number of time intervals required to generate one cycle of the desired waveforms. At this point the data memory may be loaded. In order to accomplish this, the logic levels on all channels during the first time interval or word should be converted into 'ones' and 'zeros' and loaded into the data memory at word number one. This process should then be repeated for all subsequent words. If so desired, the device may be clocked by an external clock source. This provides for synchronous system operation or operation at frequencies not obtainable using the device's internal clock source.

1.3.2 Application of the Timing Simulator Mode

Having selected the Timing Simulator mode, the desired output waveform should be divided into a series of time intervals. A level transition on any channel constitutes the end of the previous time interval and the beginning of a new one. Once the desired number of channels have

been selected the data/time memory may be loaded. For each word, both the logic levels on each channel and the relevant time interval must be programmed. The number of the last word may be determined by counting the number of words required to generate one complete cycle of the waveforms.

1.4

SPECIFICATIONS

Memory Capacity: 256x26

MODE	NUMBER OF CHANNELS	NUMBER OF BITS PER CHANNEL
TIMING SIMULATOR	1 through 8	256
WORD GENERATOR	1	4096
	2	2048
	4	1024
	8	512
	16	256

Period Resolution and Range:

RESOLUTION	RANGE
10 ns	10 ns
20 ns	20 ns - 980 ns
0.1 us	0.1 us - 99.9 us
1 us	1 us - 999 us
0.01 ms	0.01 ms - 9.99 ms
0.1 ms	0.1 ms - 99.9 ms
1 ms	1 ms - 999 ms

Operating Frequency: (WORD GENERATOR MODE)

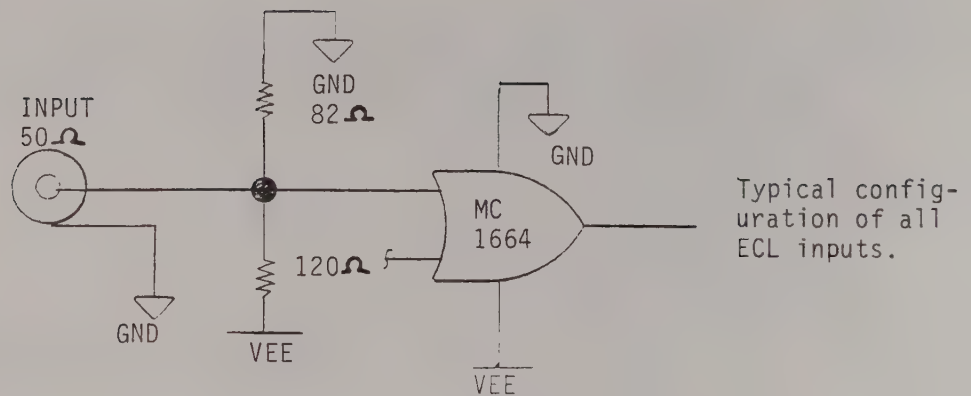
INTERNAL CLOCK = 1.001 HZ - 100 MHZ (See Note)

EXTERNAL CLOCK = D.C. - 100 MHZ (See Note)

NOTE: Selecting an odd number of bits per channel or the 16 channel mode limits the maximum operating frequency to 50 MHZ (internal and external).

ECL Input Signals: EXTERNAL TRIGGER, EXTERNAL CLOCK

Reference appendix A for pin designations of rear panel I/O connector.



All ECL inputs have ECL compatible logic levels:

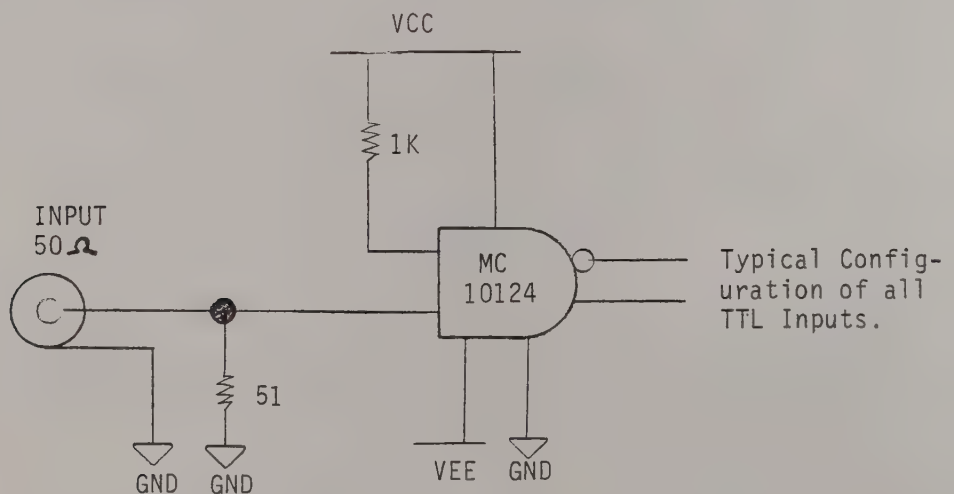
High = -1.095 Vdc min., 0 Vdc max.

Low = -5.2 Vdc min., -1.485 Vdc max.

	<u>Resident Level</u>	<u>Active Edge</u>	<u>Max. Freq.</u>	<u>Min. Pulse Width</u>
External Clock	Low	+VE	100 MHZ	5 ns.
External Trigger	Low	-VE	25 MHZ	20 ns.

TTL Input Signals: EXTERNAL TRIGGER, EXTERNAL CLOCK, EXTERNAL OSCILLATOR.

Reference Appendix A for pin designations of rear panel I/O connector.



All TTL inputs have TTL compatible logic levels:

High = +2.0 Vdc min, +5.5 Vdc max.
Low = -0.5 Vdc min, +0.8 Vdc max.

	<u>Resident Level</u>	<u>Active Edge</u>	<u>Max. Freq.</u>	<u>Min. Pulse Width</u>
External Oscillator			100 MHZ	
External Clock	Low	+VE	100 MHZ	5 ns
External Trigger	Low	-VE	25 MHZ	20 ns

ECL Output Signals: GATED OUTPUT CLOCK, GATED OUTPUT CLOCK, PROGRAM SYNC, SYNC BIT 1 and DATA OUTPUTS 0-F.

Reference Appendix A for pin designations of rear panel I/O connector.

All ECL drivers are 50 Ω Series terminated, capable of supplying ECL compatible logic levels:

Low ("0") = -1.7 Vdc max. (1 ECL 10,000 Series Load)
High ("1") = -0.9 Vdc min. (1 ECL 10,000 Series Load)

Rise and Fall Times (measured using 3 ft. of 50 Ω coax, unterminated) = 3 ns (20% - 80%).

Skew:

Data Channel to Data Channel (TSDD) = 2.0 ns (Typ.)
Gated Output Clock to Data Channel (TDCD) = 5.0 ns (Typ.)
Gated Output Clock to Sync Output (TDCS) = 3.0 ns (Typ.)
External Input Clock to Gated Output Clock (TDECC) = 50 ns (Typ.)
External Input Clock to Data Channel (TDECD) = 55 ns (Typ.)
External Input Clock to Sync Output (TDECS) = 53 ns (Typ.)

Non-continuous Mode:

External Trigger Input to word 2 Data Output (TDTD) = 97 ns
+ 1st word period (Typ.)

Reference Figures 1.3 and 1.4.

TTL Output Signals: GATED OUTPUT CLOCK, GATED OUTPUT CLOCK, PROGRAM SYNC, SYNC BIT 1 and DATA OUTPUTS 0-F.

Reference Appendix A for pin designations of rear panel I/O connector.

All TTL drivers are 50 Ω series terminated, capable of supplying TTL compatible logic levels:

Low ("0") = 0.5 Vdc max. (one 74SXX Series Load)
High ("1") = 2.4 Vdc min. (one 74SXX Series Load)

Rise and Fall Times (measured using 3 ft. of 50 Ω coax, unterminated) = 4.0 ns max. (20% - 80%).

Skew:

Data Channel to Data Channel (TSDD) = 2.0 ns (Typ.)
Gated Output Clock to Data Channel (TDCD) = 6.0 ns (Typ.)
Gated Output Clock to Sync Output (TDCS) = 3.0 ns (Typ.)
External Input Clock to Gated Output Clock (TDECC) = 65 ns (Typ.)
External Input Clock to Data Channel (TDECD) = 71 ns (Typ.)
External Input Clock to Sync Output (TDECS) = 68 ns (Typ.)

Non-continuous Mode:

External Trigger Input to word 2 Data Output (TDTD) = 105 ns
+ 1st word period (Typ.)

(Reference Figs. 1.3, 1.4, and 1.5)

Signal Interface Connectors:

Front Panel

Standard BNC Connectors

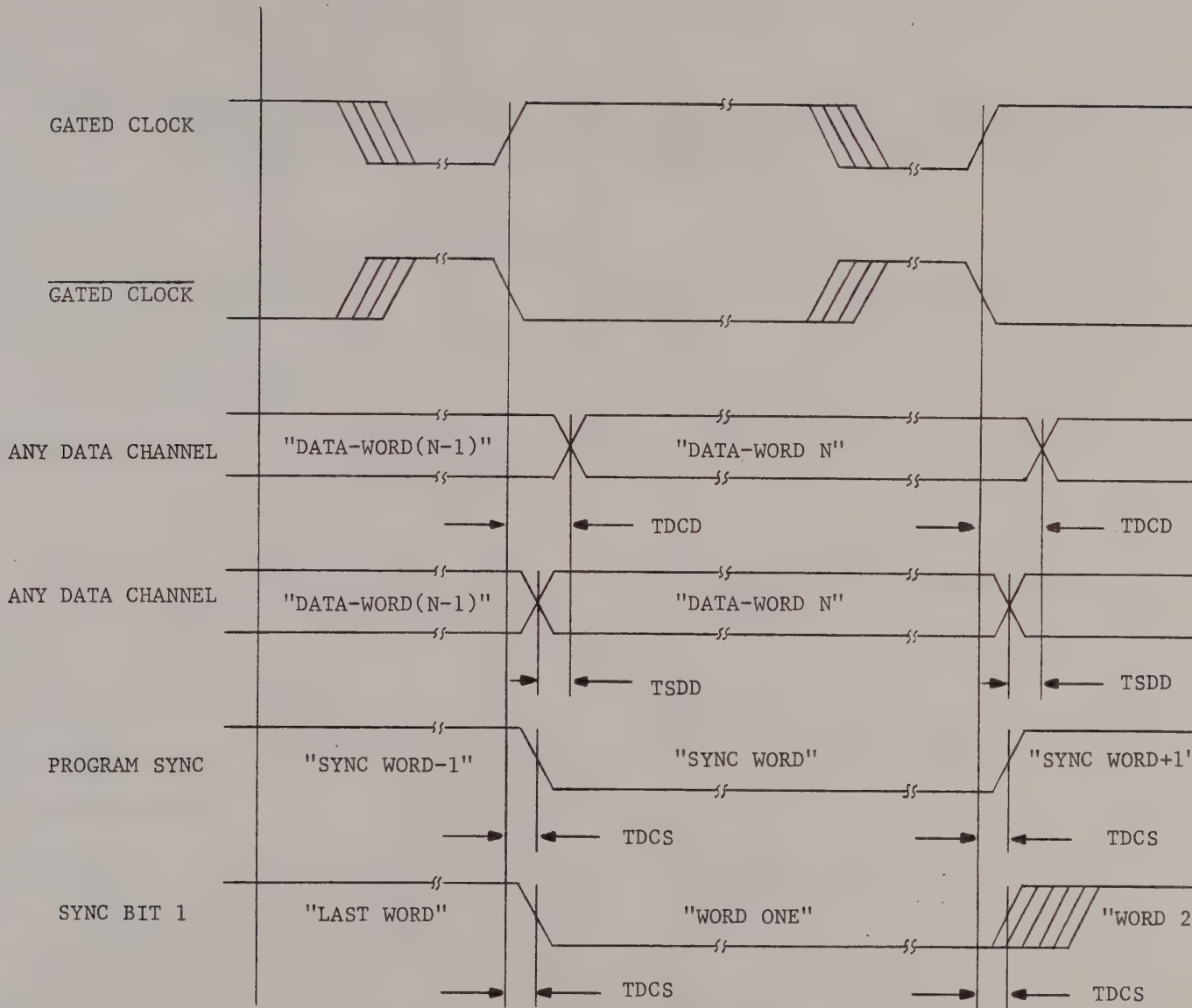
Channel Outputs 0 - F
SYNC BIT 1
PROGRAMMED SYNC BIT
GATED CLOCK
GATED CLOCK
EXTERNAL CLOCK INPUT
EXTERNAL TRIGGER INPUT

Rear Panel

Standard BNC Connector

EXTERNAL OSCILLATOR

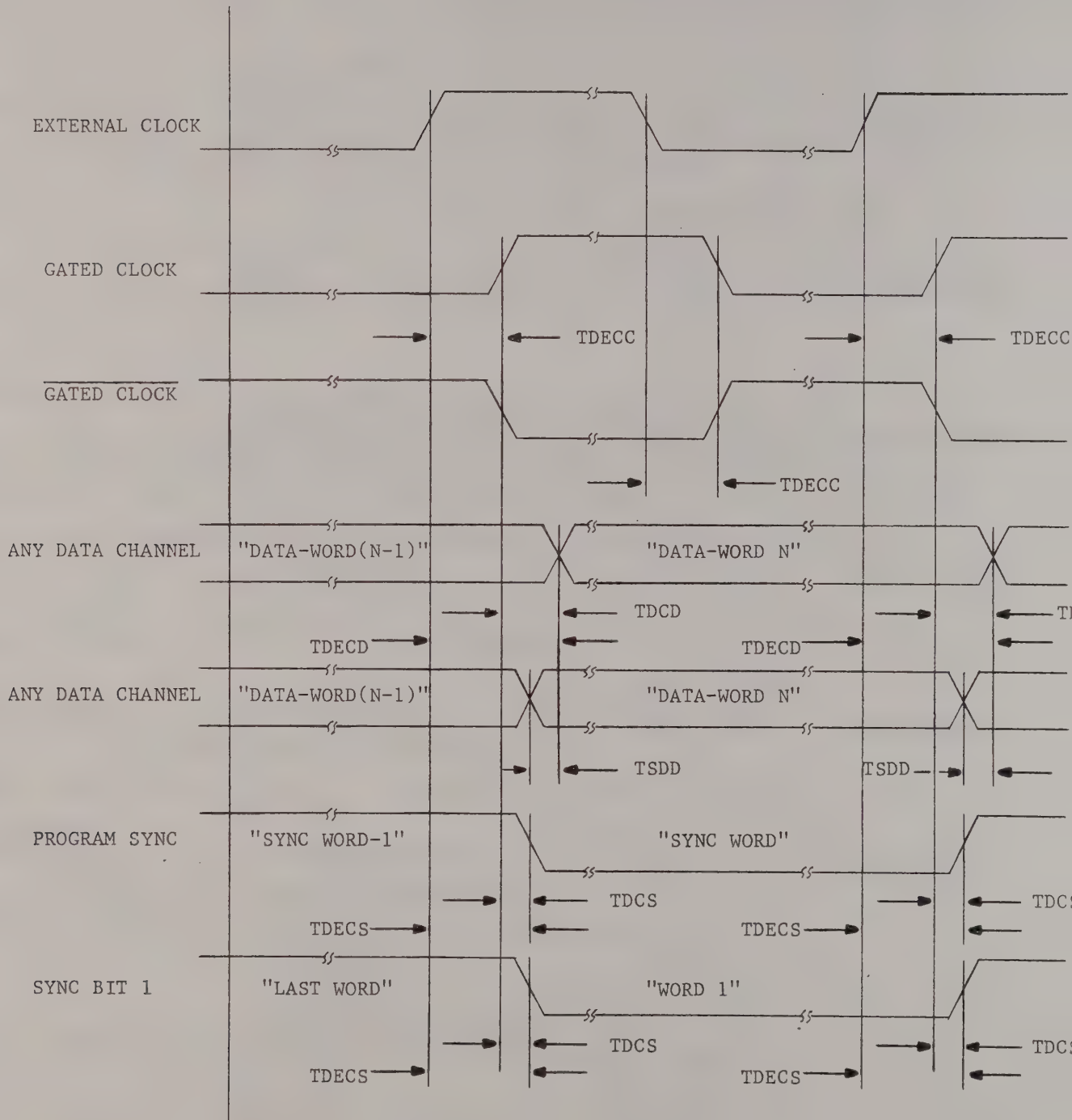
FIGURE 1.3
TIMING RELATIONSHIPS - INTERNAL CLOCK MODE



NOTE: ALL TIMING MEASUREMENTS ARE REFERRED TO 50% POINTS.

FIGURE 1.4

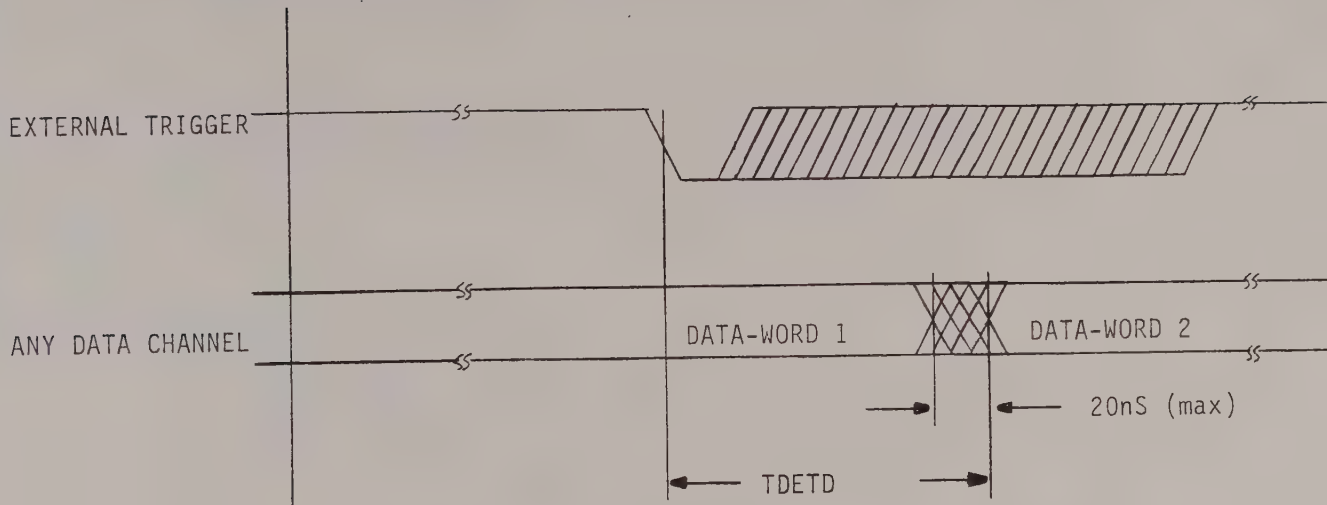
TIMING RELATIONSHIPS - EXTERNAL CLOCK MODE



NOTE: ALL TIMING MEASUREMENTS ARE REFERRED TO 50% POINTS.

FIGURE 1.5

TIMING RELATIONSHIPS - EXTERNAL TRIGGER



Power: 1-0/120 Vac. $\pm$ 10%, 50/60 HZ or 220/240 Vac. $\pm$ 10%
50/60 HZ; Specified at time of order. 300 W. max.

Dimensions:

Height = 178 mm (7 in.)
Width = 432 mm (17 in.)
Depth = 430 mm (16.8 in.) including 46 mm (1.8 in.) for
handles
Weight = 13.6 kg. (30 lbs.)

II. INSTALLATION AND MAINTENANCE

2.1 INSTALLATION

2.1.1 Unpacking and Inspection

The Model RS-680 is packed in a molded, plastic foam form, within a cardboard carton. The molded form holds the unit securely in the carton and absorbs any reasonable external shock, normally encountered in transit. Carefully remove the unit from the carton and inspect the exterior of the instrument for any signs of damage.

The shipping container and packing material should be retained, in case reshipment is required.

Included in the shipping container with the instrument are the instruction manual, power cord and external option accessories.

2.1.2 Mechanical Installation

The Model RS-680 is equipped with a collapsible tilt bail, which may be used to elevate the front of the instrument for convenient bench use.

The instrument may be mounted in a standard 19 inch rack with the optional rack-mount kit (option 680-006). To install, remove the small, decorative side panels located near the front of the instrument. Attach each of the rack-mount flanges, using the two screws supplied.

2.1.3 Electrical Installation

Prior to connecting power to the Model RS-680, confirm that the primary power source is compatible with the unit's source requirements. The Model RS-680 is fitted with a separate AC connector and fuse holder on the rear panel.

The AC fuse is mounted on the rear panel and, in the event of failure, should only be replaced with a fuse of the correct rating, as outlined below:

- a) Units designed to operate from a 100/120 Vac supply require a 3 AMP fuse.
- b) Units designed to operate from a 200/240 Vac supply require a 1.5 AMP fuse.

2.1.4 Signal Level Selection

Front panel signal levels may be selected as either ECL or TTL. These signal interfaces are specified in section 1.4. The level indicator LEDs designate the front panel selection. To change the levels on the front panel, the following steps must be taken:

- 1) Disconnect AC power
- 2) Remove bottom cover screws and slide bottom cover off the instrument.
- 3) Carefully disconnect coaxial connector P27 from the driver board assembly, P/N 1001 1326, (connector J1-ECL level or J2-TTL level) and reinstall in the opposite connector. Reference Figure 2.1.
- 4) Reinstall bottom cover
- 5) Connect AC power and verify the desired level selection by observing the LEVEL indicators.

NOTE: If the instrument is equipped with rear panel I/O, option 680-009, two connectors will be installed in the driver board output. P27 provides connection to the front panel and P28 to the rear. To change levels, front to rear, these connectors must be swapped between J1 and J2 on the driver assembly.

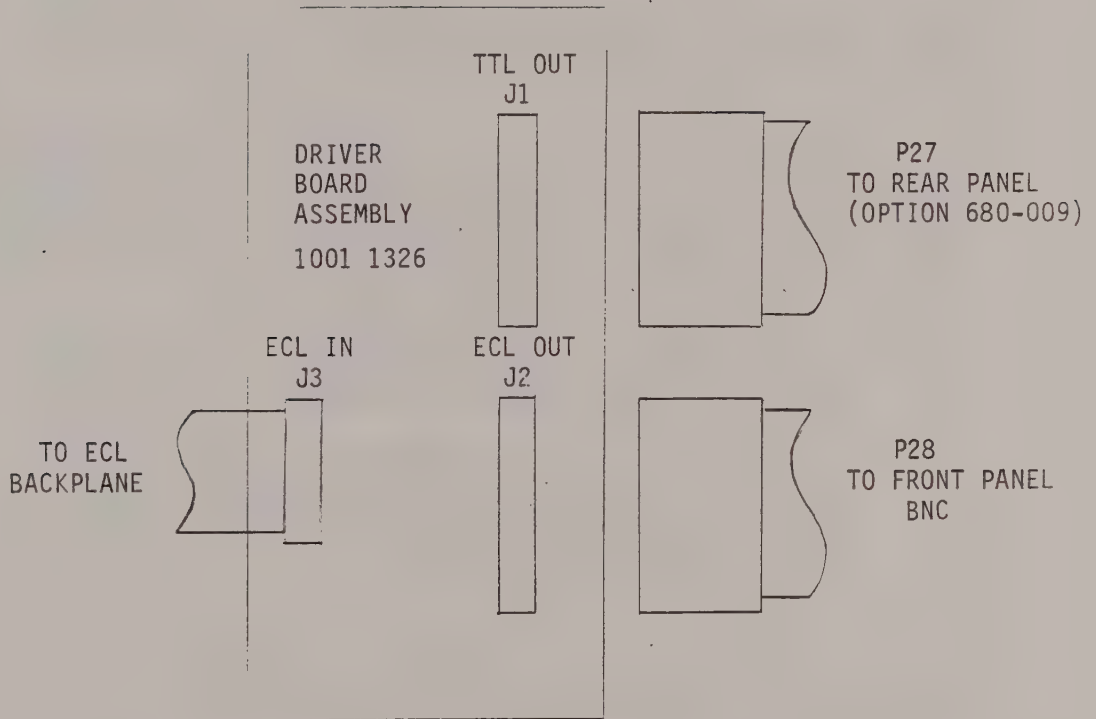
The RS-680 is shipped from the factory with ECL outputs selected to the front panel.

An AC line cord, having a three-pin plug, is supplied with the instrument. When the cord is plugged into the Model RS-680's rear panel receptacle, the round pin of the plug is connected to the instrument's chassis. This pin must be connected to a good quality earth ground, when the plug is stalled in the user's primary power receptacle.

NOTE: Chassis ground and logic ground are internally connected.

FIGURE 2.1

SIGNAL LEVEL SELECTION



2.2 FUNCTIONAL VERIFICATION

The purpose of this section is to provide calibration or metrology lab personnel with a means of verifying the correct operation of the Model RS-680. The procedure should be undertaken upon initial receipt of the unit and at the periodic maintenance interval.

It is not to be implied that this procedure will provide a 100% test of the unit. Rather, it verifies the basic performance of the Model RS-680 and will detect most of the potential problems.

The procedure is divided into six tests, each of which must be performed with the aid of an oscilloscope.

Verification Setup

Connect instrument to a compatible source of AC power and place front panel POWER switch in the ON position (upper half of switch depressed). The POWER LED should be illuminated immediately. After an initial power-up delay of approximately 10 seconds, a display resembling that shown in Figure 2.2 should be visible on the CRT.

NOTE: The level indicator LED's located on the front panel will designate the Input/Output signal levels selected to the front panel. These levels are specified in section 1.4.

Waveforms shown in the following tests represent logic indications. Actual levels will be dependent on the selected output (ECL/TTL) and their relative voltage levels.

Figure 2.2

POWER-UP DISPLAY

STATUS: PROGRAM; LOCAL CONTROL
BINARY DATA

1	MODE:	WORD GENERATOR
2	CHANNELS:	16
3	BITS/CHANNEL	256
4	DATA ENTRY:	PARALLEL
5	RUN MODE:	CONTINUOUS
6	SYNC BIT NO:	256
7	CLK SOURCE:	INTERNAL
8	CLK PERIOD:	1 USEC
9	RDY TO RUN?	

ENTER MODE _____

1 = WORD GENERATOR
2 = TIMING SIMULATOR
3 = STORED PROGRAM:

Note that application of power to the device causes the internal microprocessor to verify the correct operation of the instrument's memory. Memory failure will result in the CRT displaying the message, 'RAM FAILURE', together with diagnostic information and a procedure menu. The information supplied is comprised of the following:

- 1) the section of memory, RAM1(01-08), RAM2(09-16) or RAM3(17-24) where the failure occurred.
- 2) the hexadecimal address of the memory location that failed.
- 3) the hexadecimal data retrieved from this location.
- 4) the hexadecimal data that should have been retrieved.
- 5) the error count; i.e., the number of failures thus far.

Assuming that a memory failure has occurred, the operator may direct the device to perform any of the following functions by activating the appropriate key (1,2,3 or 4):

- 1) Continue test; i.e., test for further errors.
- 2) Bypass RAM test; i.e., enter normal operating mode.
- 3) Loop on RAM read/write; i.e., alternately write the values: '55' and 'AA' into memory location '0000'.
- 4) Loop on address pattern; i.e., continually increment memory address.

An example of memory failure display is shown in Figure 2.3.

CAUTION:

It is possible for certain, extraordinary device malfunctions to interfere with the normal operation of the CRT unit. If any of the following symptoms occur, the unit should be powered down immediately, as prolonged operation, under these conditions, may result in damage to the CRT unit:

- a) Loss of horizontal or vertical synchronization, indicated by display roll or tearing.
- b) Loss of horizontal or vertical deflection, indicated by display being reduced to a bright line or spot.
- c) Incorrect horizontal drive frequency, indicated by duplicated or partial display and accompanied by audible transformer whine.

Figure 2.3
Memory Failure Display

```
RAM TEST FAILURE

FAILURE RAM      1

HEX ADDRESS      001
HEX DATA        00
HEX DATA S/B    01
ERROR COUNT      1

OPTIONS:

1 CONTINUE TEST
2 BYPASS RAM TEST
3 LOOP ON RAM READ/WRITE
4 LOOP ON ADDRESS PATTERN
```

TEST #1 WORD GENERATOR 16 CHANNEL

Procedure:

- 1) Having obtained a display that resembles that shown in Figure 2.2 following application of power to the instrument, activate the keys marked "3" and ENTR respectively. Successively activate the following keys and observe that the resultant display is depicted by figure 2.4.

"9", "9", "0" and ENTR

Figure 2.4

STORED PROGRAM NO. 990 CONTROL DISPLAY

STATUS: PROGRAM; LOCAL CONTROL BINARY	
1 MODE:	PGM 990 WRD GEN
2 CHANNELS:	16
3 BITS/CHAN:	16
4 DATA ENTRY:	PARALLEL
5 RUN MODE:	CONTINUOUS
6 SYNC BIT NO:	1
7 CLOCK SOURCE:	INTERNAL
8 CLOCK PERIOD:	0100 NSEC
9 RDY TO RUN?	
ENTER NO. OF CHANNELS _ _	
1,2,4,8,16	

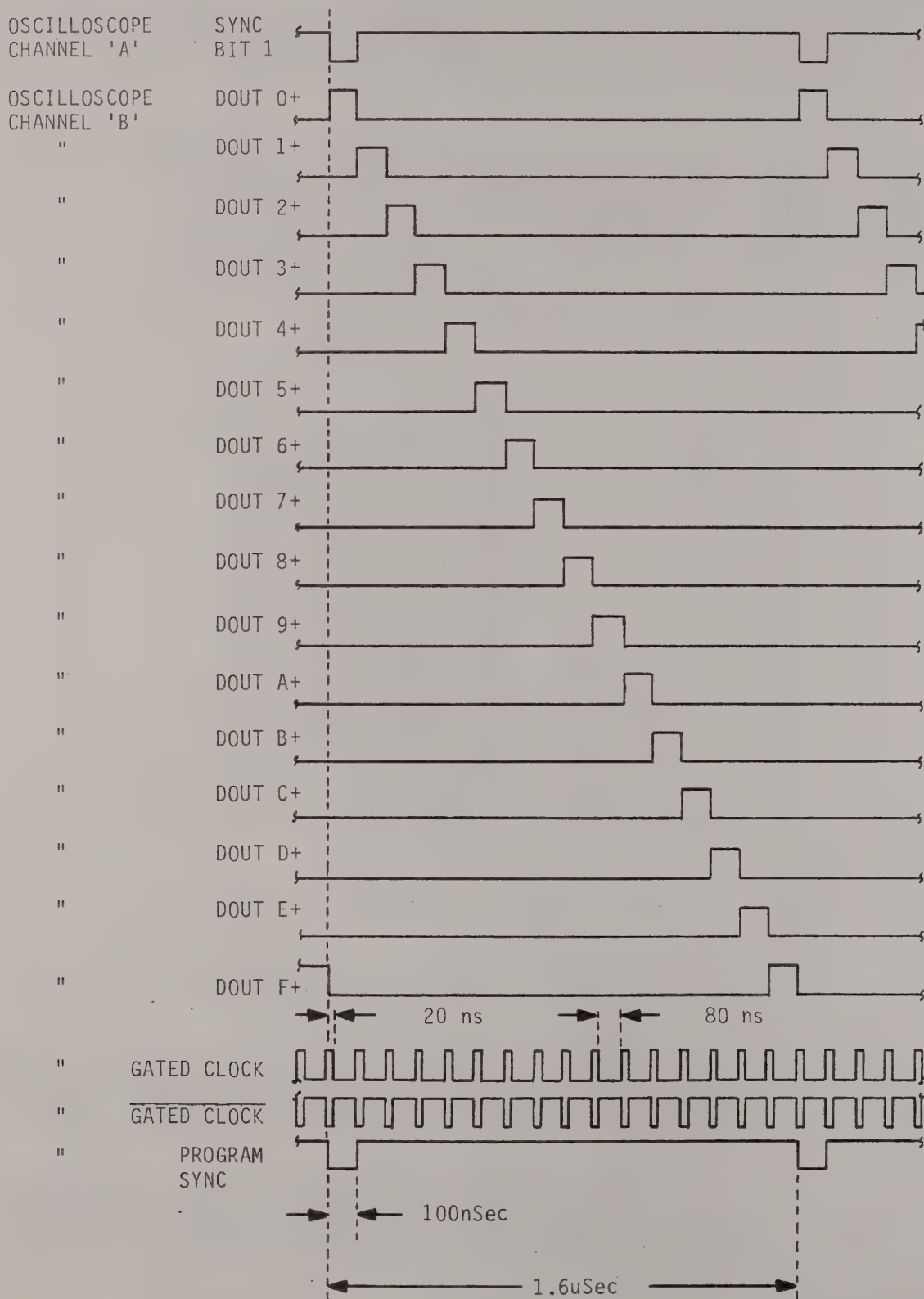
- 2) Activate the key marked CONTROL/DATA and verify that the display is as shown in figure 2.5.

Figure 2.5
STORED PROGRAM NO. 990 DATA DISPLAY

	CHANNEL			
	0123	4567	89AB	CDEF
1S	1000	0000	0000	0000
2	0100	0000	0000	0000
3	0010	0000	0000	0000
4	0001	0000	0000	0000
5	0000	1000	0000	0000
6	0000	0100	0000	0000
7	0000	0010	0000	0000
8	0000	0001	0000	0000
9	0000	0000	1000	0000
10	0000	0000	0100	0000
11	0000	0000	0010	0000
12	0000	0000	0001	0000
13	0000	0000	0000	1000
14	0000	0000	0000	0100
15	0000	0000	0000	0010
16L	0000	0000	0000	0001

- 3) Again activate the CONTROL/DATA key, followed by the RUN/PROGRAM key.
- 4) Connect channel A of an oscilloscope to the SYNC Bit 1 connector, on the front panel of the Model RS-680. Set the oscilloscope timebase to 200nsec/DIV. and trigger on the negative edge of Channel A.
- 5) Using channel B of the oscilloscope, verify that the PROGRAM SYNC, GATED CLOCK, GATED CLOCK AND data output channels (0-F) bear the same relationships to the SYNC BIT 1 output as depicted by Figure 2.6.

Figure 2.6
STORED PROGRAM NO. 990 OUTPUT WAVEFORMS



TEST #2 WORD GENERATOR 8 CHANNEL

Procedure:

- 1) Obtain the CONTROL display, by activating the CONTROL/ DATA key, home the CURSOR by activating the HOME key.
- 2) Activate the "3" and ENTR keys to enter the STORED PROGRAM MODE.
- 3) Call STORED PROGRAM number 991.
- 4) Verify that the CONTROL and DATA displays resemble those depicted in Figures 2.7 and 2.8.

Figure 2.7
STORED PROGRAM NO. 991 CONTROL DISPLAY

STATUS: PROGRAM; LOCAL CONTROL	
BINARY DATA	
1	MODE: PGM 991 WRD GEN
2	CHANNELS: 8
3	BITS/CHANNEL: 9
4	DATA ENTRY: PARALLEL
5	RUN MODE: CONTINUOUS
6	SYNC BIT NO: 2
7	CLOCK SOURCE: INTERNAL
8	CLOCK PERIOD: 0002 USEC
9	RDY TO RUN?
ENTER NO. OF CHANNELS _ _	
1,2,4,8,16	

Figure 2.8
STORED PROGRAM NO. 991 DATA DISPLAY

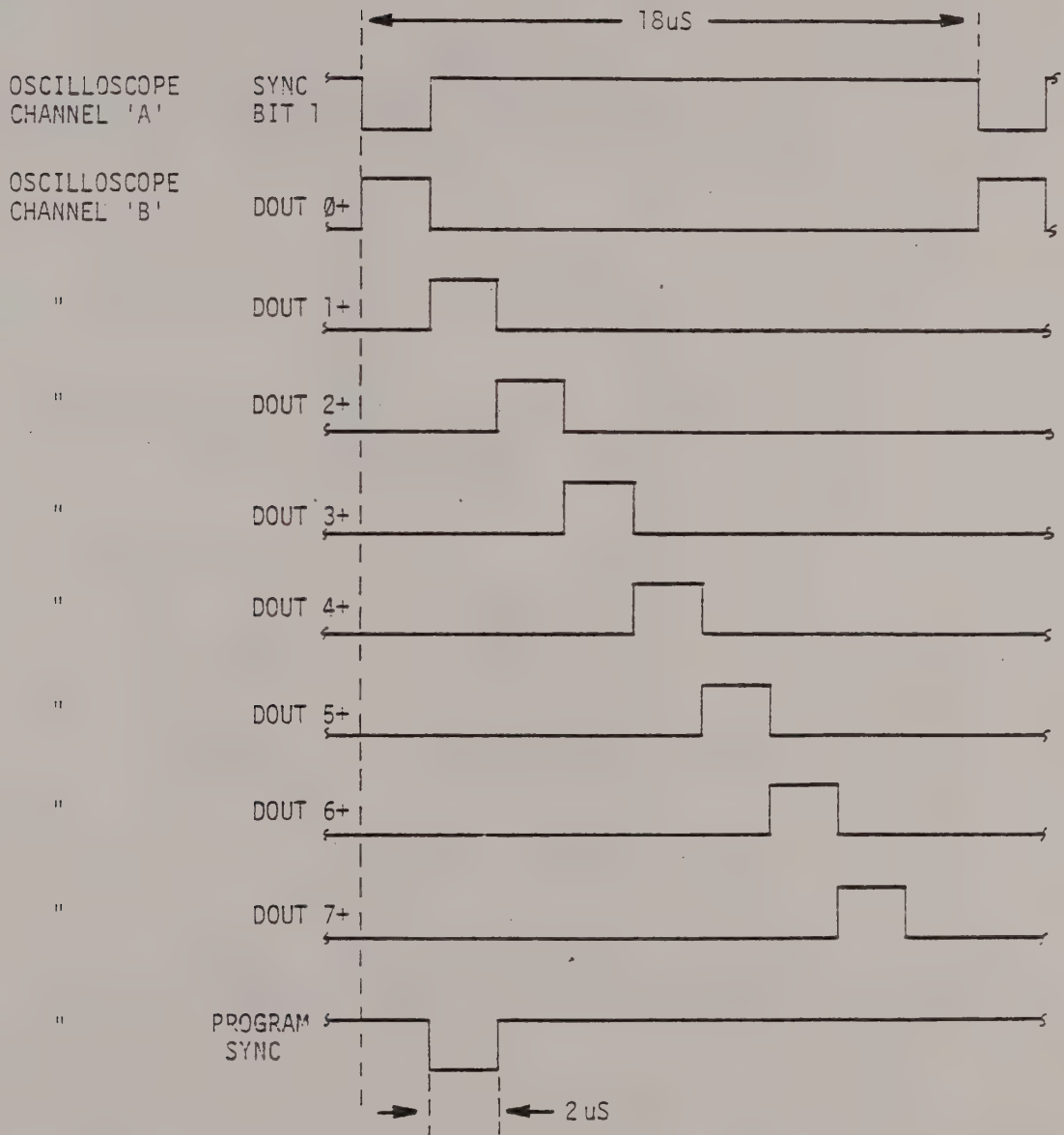
WORD	CHANNEL		WORD	CHANNEL	
	0123	4567		0123	4567
1	1000	0000	17	XXXX	XXXX
2S	0100	0000	18	↓	↓
3	0010	0000	19		
4	0001	0000	20		
5	0000	1000	21		
6	0000	0100	22		
7	0000	0010	23		
8	0000	0001	24		
9L	0000	0000	25		
10	XXXX	XXXX	26		
11	↓	↓	27		
12			28		
13			29		
14			30		
15			31		
16	XXXX	XXXX	32	XXXX	XXXX

NOTE: X=DON'T CARE

- 5) Set the unit to RUN and verify that the PROGRAM SYNC, GATED CLOCK and data output channels (0-7) bear the same relationships to the SYNC BIT 1 as depicted by Figure 2.9.

Adjust oscilloscope time base as required.

Figure 2.9
STORED PROGRAM NO. 991 OUTPUT WAVEFORMS



TEST #3 WORD GENERATOR 4 CHANNEL

Procedure:

- 1) Call STORED PROGRAM number 992 and verify that the CONTROL and DATA displays resemble those depicted in Figures 2.10 and 2.11.

Figure 2.10
STORED PROGRAM NO. 992 CONTROL DISPLAY

STATUS: PROGRAM; LOCAL CONTROL	
BINARY DATA	
1	MODE: PGM 992 WRD GEN
2	CHANNELS: 4
3	BITS/CHANNEL: 6
4	DATA ENTRY: PARALLEL
5	RUN MODE: CONTINUOUS
6	SYNC BIT NO: 3
7	CLOCK SOURCE: INTERNAL
8	CLOCK PERIOD: 0500 USEC
9	RDY TO RUN?
ENTER NO. OF CHANNELS --	
1,2,4,8,16	

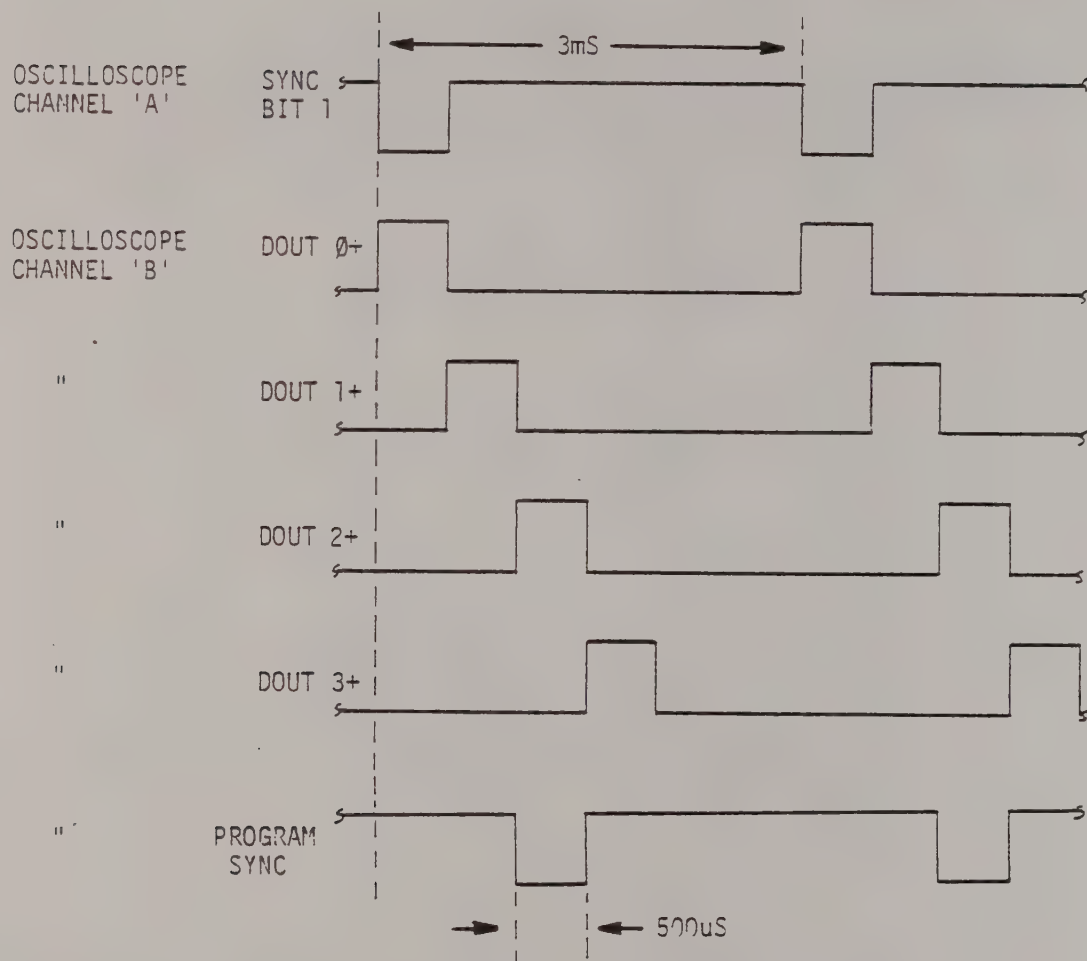
Figure 2.11
STORED PROGRAM NO. 992 DATA DISPLAY

WORD	CHANNEL	WORD	CHANNEL
	0123		0123
1	1000	17	XXXX
2	0100	18	
3S	0010	19	
4	0001	20	
5	0000	21	
6L	0000	22	
7	XXXX	23	
8		24	
9		25	
10		26	
11		27	
12		28	
13		29	
14		30	
15		31	
16	XXXX	32	XXXX

NOTE: X=DON'T CARE

- 2) Verify that setting the unit to RUN, yields the waveforms shown in Figure 2.12. Adjust oscilloscope time-base as required.

Figure 2.12
STORED PROGRAM NO. 992 OUTPUT WAVEFORMS



TEST #4 WORD GENERATOR 2 CHANNEL

Procedure:

- 1) Call STORED PROGRAM number 993 and verify that the CONTROL and DATA displays resemble those depicted by Figures 2.13 and 2.14.

Figure 2.13
STORED PROGRAM NO. 993 CONTROL DISPLAY

STATUS: PROGRAM; LOCAL CONTROL BINARY DATA	
1	MODE: PGM 993 WRD GEN
2	CHANNELS: 2
3	BITS/CHANNEL: 12
4	DATA ENTRY: PARALLEL
5	RUN MODE: CONTINUOUS
6	SYNC BIT NO: 5
7	CLOCK SOURCE: INTERNAL
8	CLOCK PERIOD: 0001 MSEC
9	RDY TO RUN?
ENTER NO. OF CHANNELS --	
1,2,4,8,16	

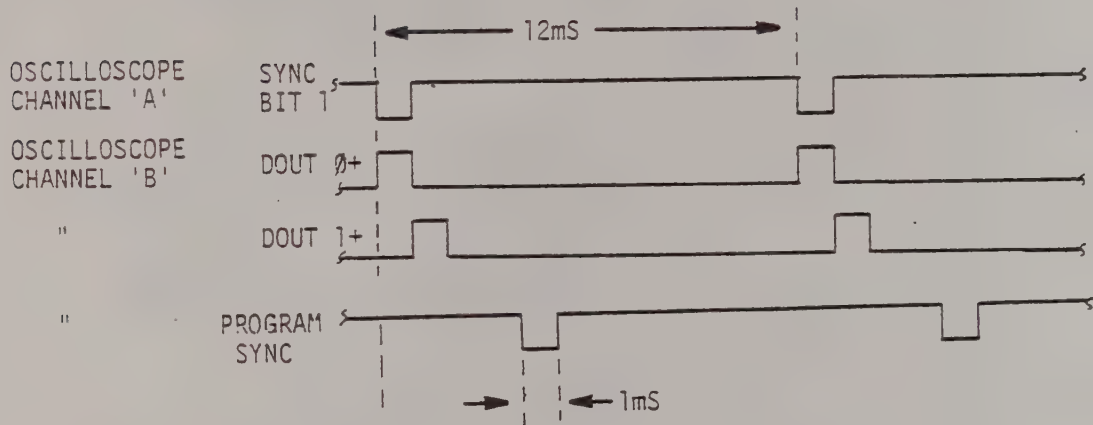
FIGURE 2.14
STORED PROGRAM NO. 993 DATA DISPLAY

CURSOR BIT 1				
	1 - - - - BIT - - - - 16			
CHAN			L	
0	1000	0000	0000	XXXX
1	0100	0000	0000	XXXX
		S		
	17 - - - -BIT- - - - 32			
CHAN				
0	XXXX	XXXX	XXXX	XXXX
1	XXXX	XXXX	XXXX	XXXX

NOTE: X = DON'T CARE

- 2) Verify that setting the unit to RUN yields the waveforms shown in Figure 2.15. Adjust time-base as required.

Figure 2.15
STORED PROGRAM NO. 993 OUTPUT WAVEFORMS



TEST #5 WORD GENERATOR SINGLE CHANNEL

Procedure:

- 1) Call STORED PROGRAM number 994 and verify that the CONTROL and DATA displays resemble those depicted by Figures 2.16 and 2.17.

Figure 2.16
STORED PROGRAM NO. 994 CONTROL DISPLAY

STATUS: PROGRAM; LOCAL CONTROL	
BINARY DATA	
1	MODE: PGM 994 WRD GEN
2	CHANNELS: 1
3	BITS/CHANNEL: 25
4	DATA ENTRY: PARALLEL
5	RUN MODE: CONTINUOUS
6	SYNC BIT NO: 9
7	CLOCK SOURCE: INTERNAL
8	CLOCK PERIOD: 0020 NSEC
9	RDY TO RUN?

ENTER NO. OF CHANNELS _ _

1,2,4,8,16

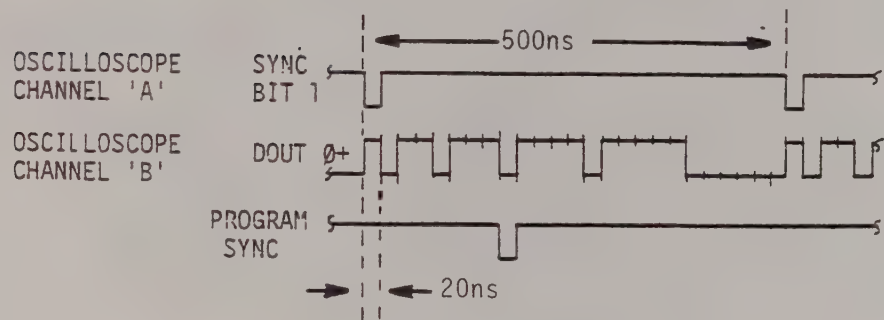
Figure 2.17
STORED PROGRAM NO. 994 DATA DISPLAY

CURSOR BIT 1													
	1	-	-	-	-	BIT	-	-	-	-	-	16	
CHAN	0	1011	0111	0111	1011								
				S									
		17	-	-	-	-	BIT	-	-	-	-	-	32
CHAN	0	1110	0000	0XXX	XXXX								
				L									

NOTE: X = DON'T CARE

- 2) Verify that setting the unit to RUN yields the waveforms shown in Figure 2.18. Adjust time-base as required.

Figure 2.18
STORED PROGRAM NO. 994 OUTPUT WAVEFORMS



TEST #6 TIMING SIMULATOR 8 CHANNEL

Procedure:

- 1) Call STORED PROGRAM number 995 and verify that the CONTROL and DATA displays resemble those depicted by Figures 2.19 and 2.20.

Figure 2.19
STORED PROGRAM NO. 995 CONTROL DISPLAY

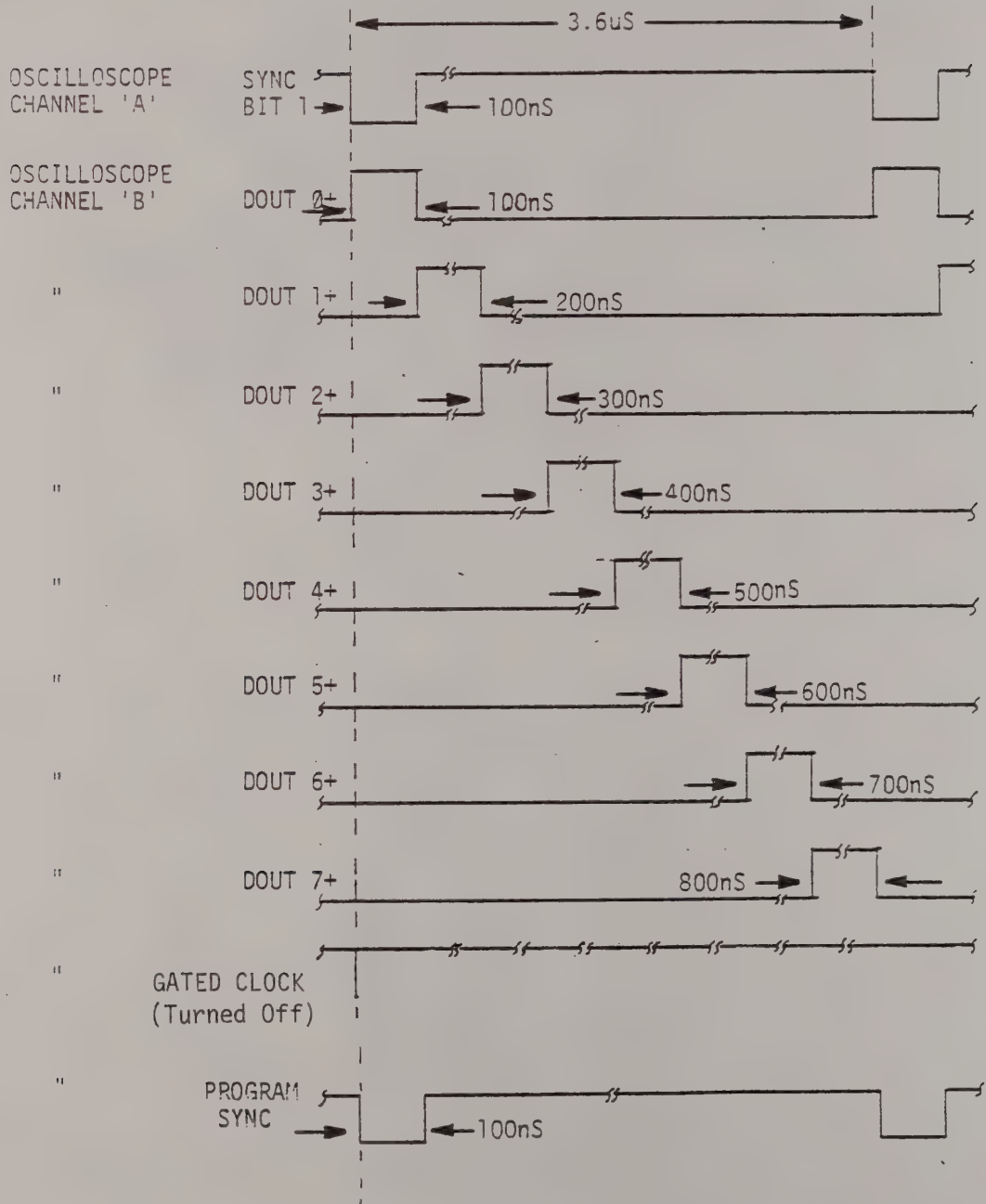
STATUS: PROGRAM; LOCAL CONTROL		
BINARY DATA		
1	MODE:	PGM 995 TIM SIM
2	CHANNELS:	8
3	LAST WORD:	8
4	DATA ENTRY:	PARALLEL
5	RUN MODE:	CONTINUOUS
6	SYNC WORD:	1
7	RDY TO RUN?	
ENTER NO. OF CHANNELS _ _		
1 THRU 8		

Figure 2.20
STORED PROGRAM NO. 995 DATA DISPLAY

		CHANNEL		PERIOD
WORD		0123 - 4567		
1	S	1000	0000	.1 US
2		0100	0000	.2 US
3		0010	0000	.3 US
4		0001	0000	.4 US
5		0000	1000	.5 US
6		0000	0100	.6 US
7		0000	0010	.7 US
8	L	0000	0001	.8 US
ENTER BINARY DATA.				

- 2) Verify that setting the unit to RUN yields the waveforms shown in Figure 2.21. Adjust time-base as required.

Figure 2.21
STORED PROGRAM NO. 995 OUTPUT WAVEFORMS



2.3 CALIBRATION

Being a digital instrument, the Model RS-680 requires limited calibration in the conventional sense. It is recommended that the power supply voltage be checked/adjusted every six months as follows:

- 1) With power applied to the unit, remove the top cover.

CAUTION

Hazardous voltages are contained within this device. Therefore, extreme caution should be exercised, while the top cover is not in position.

Care should also be taken, not to short-circuit any of the power supplies; although such action should not damage the supplies, the erasable programmable read only memories (EPROM's) may well be damaged or altered.

- 2) Connect a DVM across the tantalum capacitor (C30) at the rear of the upper logic assembly. Observe the polarity markings on the capacitor. Reference drawing number 1001 1321.

NOTE: The inputs DVM should be floating with respect to earth and chassis ground.

- 3) The voltage at this point should be $+5.20 \text{ Vdc} \pm 0.05 \text{ Vdc}$.
4. In order to adjust this voltage, locate the voltage adjustment access hole on the rear panel, above the A.C. connector. Reference drawing number 1001 1328. Carefully insert an insulated shaft, screwdriver and rotate slowly until the DVM registers the correct voltage.

It is also recommended that the Functional Verification Procedure, section 2.2, be performed after calibration.

Maintenance documentation for the RS-680 consists of the logic diagrams located in Appendix C and the service manual for the CRT (provided in Appendix D).

The RS-680 contains voltages hazardous to personnel, especially in the area of the CRT. Maintenance procedures therefore should only be conducted by qualified personnel.

In order to perform fault corrective maintenance, the user must be familiar with the RS-680 logic diagrams. Basically, the lower logic panel assembly includes the high speed word generator and timing simulator logic. The Input/Output driver board, located below the CRT (accessed from the bottom of the instrument), provides output drivers and input receivers for both ECL and TTL levels. The remaining assemblies (front panel keyboard, CRT and upper logic panel) are simply the means of interfacing the operator with the word generator/timing simulator.

During power-up initialization, the CPU performs a memory test (Reference Section 2.2). If the CRT then results in the display shown in Figure 2.2, it may be assumed the CRT, CPU, and memory are functional. Until the RS-680 is set into the run mode, the lower logic panel assembly may be essentially disregarded as a source of problems. Power-up initialization does include tests of the word memory which is located on the lower panel. If the unit is capable of being programmed as indicated by the expected CRT displays, and yet generates incorrect output patterns when set to the run mode, the lower logic panel may be assumed to be the source of the problems.

III. LOCAL CONTROL OPERATION

This section describes the operation of the Model RS-680 under local control, using the front panel controls and indicators.

Initiation of communications between the Model RS-680 and a remote, controlling device causes the unit to go into remote control operation (Note the status will only indicate REMOTE CONTROL when the remote communication requests a CRT display update; reference Section 4.2.2). Depressing the HOME/RESET key returns control of the unit to the front panel and the Model RS-680 will remain in this mode until the remote controlling device again initiates communications.

3.1 CONTROL AND INDICATORS

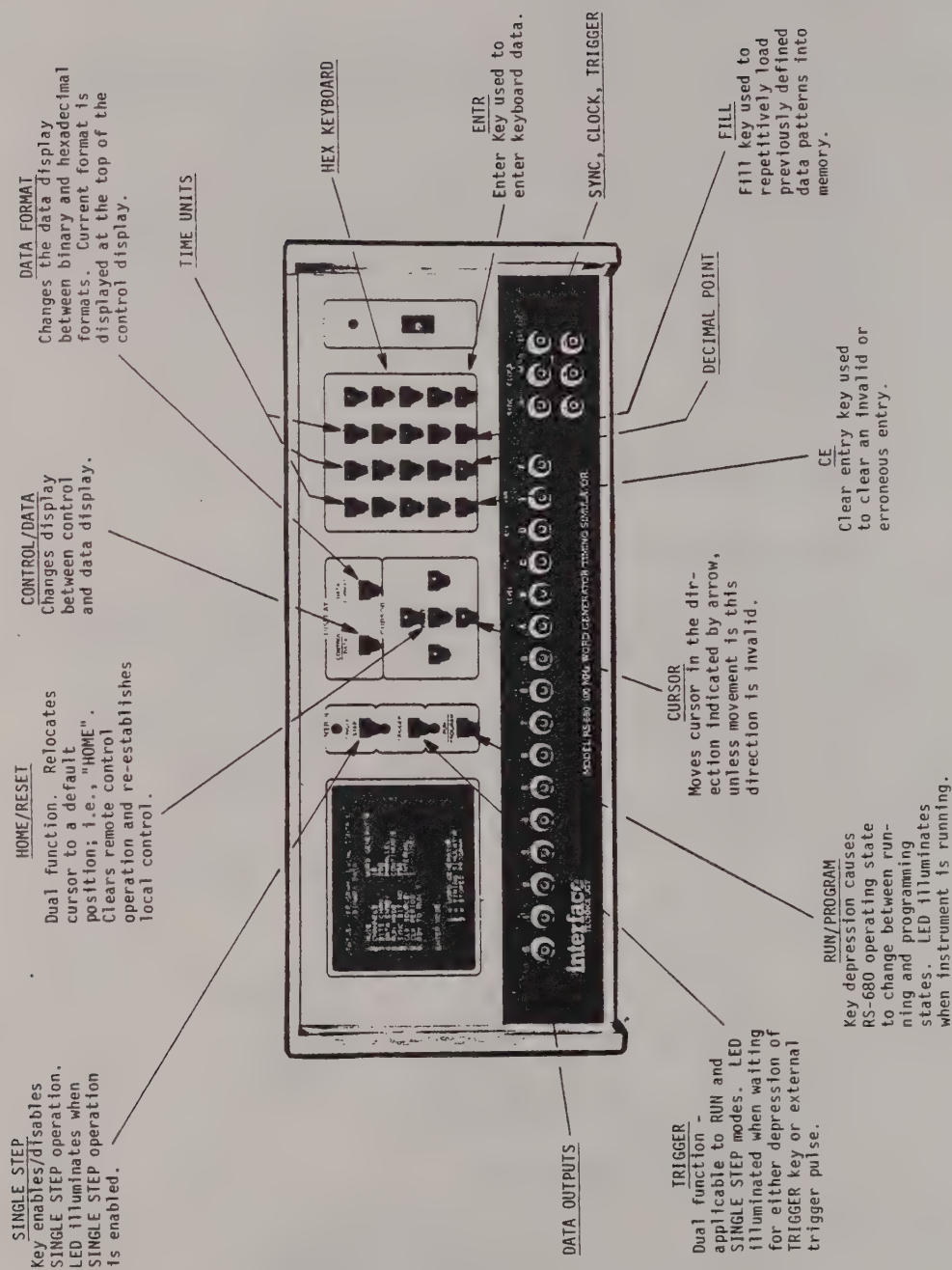
Figure 3.1 illustrates the front panel controls and indicators of the Model RS-680.

3.1.1 POWER Switch and LED

Activation of the POWER switch causes the Model RS-680 to execute its initialization routine which results in the POWER LED being illuminated and the CRT presenting the following display:

STATUS: PROGRAM; LOCAL CONTROL	
BINARY DATA	
1	MODE: WORD GENERATOR
2	CHANNELS: 16
3	BITS/CHANNEL: 256
4	DATA ENTRY: PARALLEL
5	RUN MODE: CONTINUOUS
6	SYNC BIT NO: 256
7	CLK SOURCE: INTERNAL
8	CLK PERIOD: 1 USEC
9	RDY TO RUN?
ENTER MODE _____	
1 = WORD GENERATOR	
2 = TIMING SIMULATOR	
3 = STORED PROGRAM:	

FIGURE 3.1
FRONT PANEL CONTROL AND INDICATORS



3.1.2 Control Keys and Indicators

Three CONTROL keys are provided on the Model RS-680: SINGLE STEP, TRIGGER, and RUN/PROGRAM.

3.1.2.1 RUN/PROGRAM Key and LED

The RUN LED indicates whether the Model RS-680 is in the run (LED illuminated) or program (LED extinguished) mode. Its status may be changed by the activation of the RUN/PROGRAM key. Note that, when the unit is in the run mode, the following operations are illegal and are ignored:

- a) single step
- b) attempts to display data if the CONTROL format is presently being displayed
- c) cursor manipulation when displaying data
- d) data modifications or format changes
- e) attempts to modify items "1" through "4" in the CONTROL display

3.1.2.2 SINGLE STEP Key and LED

The SINGLE STEP LED illuminates when the device is in the single step mode. Its status may be reversed by the activation of the SINGLE STEP key.

3.1.2.3 TRIGGER Key and LED

The TRIGGER LED, when illuminated, indicates that the device requires a trigger. This situation will arise when one of the two following conditions exists:

- a) The device is in the run, noncontinuous mode (RUN LED is illuminated and RUN MODE=XXXX REPETITIONS) and is waiting to generate the specified number of cycles. Activation of the TRIGGER key, or a high to low transition at the TRIGGER INPUT, will initiate the execution of the specified number of repetitions and extinguish the TRIGGER LED until the completion of the last cycle. Note that the TRIGGER LED is extinguished for a minimum of 100 ms and is therefore not an exact indication of program time.

- b) The device is in the single step mode (SINGLE STEP LED also illuminated), in which case, each activation of the TRIGGER key will cause the unit to output the next word of data.

3.1.3 DISPLAY Keys

3.1.3.1 CONTROL/DATA Key

This key is used to alternate the CRT display between the CONTROL and DATA formats. Note that, when the unit is in the run mode (RUN LED illuminated), any attempts to change the display from CONTROL TO DATA will be ignored by the device.

3.1.3.2 DATA FORMAT Key

Activation of the Data Format key will alternate the DATA display between the hexadecimal and binary formats. Format changes are ignored when the unit is in the run mode (RUN LED illuminated). The current DATA FORMAT mode is presented at the top of the CONTROL display.

3.1.3.3 CURSOR Control and HOME/RESET Keys

Five cursor control keys are provided on the Model RS-680. The four direction keys move the cursor, one position per momentary activation or continuously for a prolonged activation, in the direction indicated by the arrows. The HOME/RESET key has two functions which are described below:

- 1) The HOME function is used to relocate the cursor to any output word in the DATA display or to certain parameters in the CONTROL display. In order to position the cursor to the first output word in the DATA display, depress the HOME/RESET key and then the ENTR key. The DATA cursor may be relocated by activating the HOME/RESET key, entering the desired output word number via the keyboard, and activating the ENTR key. Note that when the unit is in the RUN mode all cursor manipulation in the DATA display and all attempts to position the cursor to parameters 1 through 4 in the CONTROL display are ignored.
- 2) The RESET function is used to regain local control of the device when it is under remote control. This function may be invoked whenever the device is in the remote control mode by activating the HOME/RESET key.

Note that local and remote control each share the same priority and the Model RS-680 will therefore remain in the most recently requested mode.

3.1.4 Keyboard

The keyboard on the Model RS-680 includes 3 function keys (CE, FILL and ENTR) and 17 data keys of which three (C/nSEC, D/uSEC and E/mSEC) perform dual functions. Hexadecimal data is loaded using keys "0" through "F" whereas decimal data requires the use of keys "0" through "9" including the decimal point key if necessary. Binary data is loaded using keys "0" and "1" and units of time are loaded via the C/nSEC, D/uSEC and E/mSEC keys.

3.1.4.1 CE Key

This key is used to clear an invalid or erroneous entry and must be activated whenever the CRT is displaying INVALID.

3.1.4.2 FILL Key

The function of the FILL key is to enable the user to repeatedly load a previously defined data pattern into a specified memory area.

3.1.4.3 ENTR Key

Activation of the ENTR key signifies the completion of a particular keyboard entry and causes the cursor to be advanced to the next valid position. Note that data entries, in the DATA display, do not require activation of the ENTR key.

3.2 WORD GENERATOR MODE

This section describes the WORD GENERATOR mode of operation. When the RS-680 is operating in the WORD GENERATOR mode, the periods of succeeding output data words (or bits) are equal and determined by the period of the clock source (parameter no. 7).

3.2.1 Mode Selection

In order to select the WORD GENERATOR mode, the cursor must first be positioned to parameter no. 1. This may be accomplished either by using the two vertical cursor keys or the HOME key. At this time the entry menu in the lower portion of the display will read as follows:

ENTER MODE _____

- 1 = WORD GENERATOR
- 2 = TIMING SIMULATOR
- 3 = STORED PROGRAM

Depression of the "1" key followed by the ENTR key will result in the cursor being advanced to parameter no. "2". The parameter no. "1" display will be the following:

1 MODE: WORD GENERATOR

3.2.2 Channel Selection - WORD GENERATOR Mode

The number of output channels is defined by parameter no. "2" in the control display. In order to modify the number of channels, the cursor must first be positioned to this parameter, resulting in the following entry menu:

ENTER NO. OF CHANNELS _ _
1,2,4,8,16.

Having entered the desired number of channels, activation of the ENTR key will update the parameter and advance the cursor.

Note that selecting 16 channels restricts the minimum clock period to 20 ns.

Following selection of the WORD GENERATOR mode and the number of channels, the user's output pattern may be loaded into the data memory (reference Section 3.2.8). The remaining control parameters do not impact the data configuration.

3.2.3 Bits/Channel - WORD GENERATOR Mode

Positioning the cursor to parameter no. "3" allows the number of bits per channel to be defined and results in the following entry:

ENTER # OF BITS PER CHAN - - - - -
1 THRU XXXXX

Note that the maximum number of bits per channel (XXXXX) varies in accordance with the selected number of channels and is defined in section 1.3. In the DATA display the last word/bit is indicated by the letter "L" adjacent to the specified word or bit number.

3.2.4 Data Entry - WORD GENERATOR Mode

Parameter no. "4" specifies the method of data entry as either serial or parallel. Data entry is determined by the number of channels selected and is not a variable.

3.2.5 Run Mode - WORD GENERATOR Mode

The run mode may be either continuous or may repeat the pattern generation from 1 through 4096 times. Accessing parameter no. "5" will result in the following entry:

```
ENTER RUN MODE -----  
  
ENTER C FOR CONTINUOUS PATTERN  
OR  
ENTER 1 THRU 4096 for NO. OF  
PATTERN REPEATS PER TRIGGER
```

3.2.6 Sync Bit Number - WORD GENERATOR Mode

Selection of parameter no. "6" allows the user to define the sync bit number. The entry menu is as follows:

```
ENTER SYNC BIT NO. -----  
1 THRU XXXXX
```

Note that, in the event of the sync bit number being greater than the number of bits per channel, an asterisk will appear immediately following the sync bit number. In the DATA display, the sync word/bit is indicated by the letter "S" adjacent to the selected word or bit number.

3.2.7 Clock Source - WORD GENERATOR Mode

Parameter no. "7" enables selection of the CLOCK SOURCE and may be specified as either the internal RS-680 clock generator or a user's external clock. The clock source entry menu is shown below:

```
ENTER CLOCK SOURCE -  
1 = INTERNAL  
2 = EXTERNAL
```

3.2.8 Clock Period - WORD GENERATOR Mode

If the clock source has been defined as INTERNAL, parameter no. "8" may be accessed by the cursor to enter the desired period of the internal clock. The following entry menu will be displayed:

```
ENTER CLOCK PERIOD----SEC  
MS .001 - 999  
US .1 - 999  
NS 10, 20, 40,---980
```

Note that, selecting an odd number of bits per channel, or defining the number of channels as 16, restricts the minimum clock period to 20 ns.

If an external clock source has been selected, parameter no. "8" specifies the minimum period of the external clock.

3.2.9 Data Memory - WORD GENERATOR Mode

Once the WORD GENERATOR mode and the number of channels have been defined via the CONTROL display, the data memory may be loaded. Data may be entered in either binary or hexadecimal formats. The current entry format is indicated under status at the top of the CONTROL display. Transitions between binary and hex data formats are accomplished by activating the DATA FORMAT key.

In order to enter data, the data display must be accessed by activating the CONTROL/DATA key (assuming that the device is not already displaying data). Data may now be entered via the keyboard. Note that when entering data, it is not necessary to activate the ENTR key after each data key.

3.2.10 Run Mode Operation - WORD GENERATOR Mode

Once the parameters have been specified and the data loaded, the device may be directed to RUN by activating the RUN/PROGRAM key. This will result in the following:

- a) RUN LED is illuminated.
- b) Data generator is started.
- c) Cursor is initialized to parameter no. "5", if displaying CONTROL.
- d) Status display changes from PROGRAM to RUNNING.
- e) Cursor manipulation in the DATA display is inhibited.
- f) Attempts to position cursor to parameters "1" through "4" in the CONTROL display are inhibited.
- g) Transitions from CONTROL display to DATA display are inhibited.
- h) DATA FORMAT key activations are ignored.

In order to exit from the RUN mode, the RUN/PROGRAM key should again be activated. Note that if parameter no. "5" (run mode) has not been defined as continuous and the device is directed to run, the TRIGGER LED will be illuminated, indicating that a trigger is required. The trigger may be supplied, either by activating the TRIGGER key or by a high to low transition at the unit's rear panel EXTERNAL TRIGGER input. Either of these actions will extinguish the TRIGGER LED and cause the device to output the required data pattern for the specified number of times. The TRIGGER LED will remain extinguished for at least 100 ms and as long as the data pattern is still being generated.

3.2.11 Single Step Mode Operation - WORD GENERATOR Mode

The Model RS-680 may be operated in the single step mode by activating the SINGLE STEP key instead of the RUN/PROGRAM key. This action will result in the following:

- a) Data display is immediately invoked.
- b) SINGLE STEP and TRIGGER LEDs are illuminated.
- c) Cursor is initialized to WORD/BIT NO. 1.
- d) DATA FORMAT, CONTROL/DATA, CURSOR direction and FILL keys are all ignored.
- e) Data format is forced to binary data format.

Under these conditions, each activation of the TRIGGER key will cause the device to output the next data word bit, as indicated by the cursor advancement on the data display.

The HOME key performs a slew function in the SINGLE STEP mode. Activating the HOME key will result in the display of the word HOME and a scratch pad area. A decimal value, representing the desired word/bit number, may be entered via the keyboard followed by depression of the ENTR key. The device will output all words/bits from the one previously designated by the CURSOR to the one entered via the keyboard.

Note that if the desired word number is less than the number of the word previously designated by the cursor, the generator will wrap around via the last word.

The SINGLE STEP mode may be exited by activating either the SINGLE STEP key again or the RUN/PROGRAM key. In the latter case, the device will immediately enter the RUN mode.

3.3 TIMING SIMULATOR MODE

In the TIMING SIMULATOR mode, the periods of a channel's succeeding bits are independently programmable.

3.3.1 Mode Selection

In order to select the TIMING SIMULATOR mode of operation, the following procedure should be followed:

- a) Select CONTROL DISPLAY.
- b) Position cursor to parameter no. "1".
- c) Enter "2" via the keyboard in accordance with the entry menu.
- d) Depress the ENTR key.

3.3.2 Channel Selection - TIMING SIMULATOR Mode

The TIMING SIMULATOR mode provides for eight output channels. Parameter no. "2" permits enabling from 1 to 8 of the available channels. To

establish the number of channels, the operator must enter the desired number in accordance with the entry menu and depress the ENTR key.

Note that in the TIMING SIMULATOR mode, the selected number of channels has no effect on the maximum last word value as occurs in the WORD GENERATOR mode.

3.3.3 Last Word - TIMING SIMULATOR Mode

The number of the last word is selected using control parameter no. "3". The operator must enter the desired last word number in accordance with the entry menu and depress the ENTR key. The last word is identified on the DATA display by the letter "L".

3.3.4 Data Entry - TIMING SIMULATOR Mode

In the TIMING SIMULATOR mode, data entry (parameter no. "4") must be in parallel and is not a variable.

3.3.5 Run Mode - TIMING SIMULATOR Mode

The run mode may be either continuous or may repeat the pattern generation from 1 through 4096 times. Selection is made in accordance with the entry menu associated with control parameter no. "5".

3.3.6 Sync Word - TIMING SIMULATOR Mode

Parameter no. "6" enables selection of the sync word number. The selected word number is to be entered in accordance with the entry menu of parameter no. "6". The letter "S" is positioned adjacent to the sync word number on the DATA display.

3.3.7 Data/Time Memory - TIMING SIMULATOR Mode

Once the TIMING SIMULATOR mode and the number of channels have been selected via the CONTROL display, the data memory may be loaded. The DATA FORMAT may be either binary or hexadecimal. The currently selected DATA FORMAT status is displayed at the top of the CONTROL display. Transitions between binary and hexadecimal are accomplished by activating the DATA FORMAT key.

In order to enter the data and time, the DATA display must first be accessed by activating the CONTROL/DATA key (assuming that the device is not already displaying DATA). Data and time values may be entered via the keyboard with the aid of the CURSOR. Note that time values

are in decimal and require the use of the ENTR key, whereas data entries do not. Note also that selecting a 10 nsec period for any word will cause the device to automatically insert a second 10 nsec word. These two words are indicated as A and B. If the SYNC word happens to be a 10 ns word, the SYNC pulse will occur coincidentally with the A word.

3.3.8 Run Mode Operation - TIMING SIMULATOR Mode

The run mode for TIMING SIMULATOR operates in exactly the same fashion as the run mode for WORD GENERATOR (ref. Section 3.2.10). Note that the device may not be operated in single step while in the TIMING SIMULATOR mode.

3.4 FILL FUNCTION

Except while operating in the run or single step modes, the fill function may be invoked by activating the FILL key. In order to perform this operation, the desired data pattern should first have been entered. Activating the FILL key will result in the RS-680 requesting, by means of the CRT display, the following information:

- 1) PATTERN START WORD/BIT.
- 2) PATTERN END WORD/BIT.
- 3) NO. OF PATTERN REPEATS.
- 4) START FILL AT WORD/BIT.
- 5) RDY TO EXECUTE? PUSH ENTR.

Once all of these parameters have been entered, activating the ENTR key initiates the execution of the fill and results in the following:

- 1) The device will first verify that enough memory exists to perform the fill as directed.
- 2) Assuming that this condition is satisfied, the fill function will be executed.
- 3) The Model RS-680 will exit from the fill mode upon completion.

Note that while the function is being executed, the CRT will display the message "FILLING" and all front panel controls are locked out. The fill mode may be aborted at any stage prior to activating the ENTR key, for the last time, by activating the CONTROL/DATA key.

Example:

Assuming that it is required to repetitively load the following, hexadecimal data pattern, into words 4,5&6; 7,8&9 and 10,11&12:

WORD	CHANNEL
	0--F
1	0123
2	4567
3	89AB

The fill function should first be invoked, by activating the FILL key. The following values should then be entered:

1	PATTERN START WORD/BIT:	1
2	PATTERN END WORD/BIT:	3
3	NO. OF PATTERN REPEATS:	3
4	START FILL AT WORD/BIT:	4
5	RDY TO EXECUTE? PUSH ENTR	

The data table would then appear as follows:

WORD	CHANNEL
	0--F
1	0123
2	4567
3	89AB
4	0123
5	4567
6	89AB
7	0123
8	4567
9	89AB
10	0123
11	4567
12	89AB

3.5 STORED PROGRAM MODE

The stored program mode enables the user to call and execute "programs" (control parameters and the data/time tables) which have been previously stored in EPROMs (erasable programmable read only memories).

Using 4K x 8 EPROMs the stored program card provides the user with a maximum of 24K x 8 of storage.

3.5.1 Operation

The stored program mode may be accessed as follows:

- 1) access the CONTROL display and position the cursor to parameter "1". The following entry menu will be displayed:

```
ENTER MODE ____  
  1 = WORD GENERATOR  
  2 = TIMING SIMULATOR  
  3 = STORED PROGRAM
```

- 2) enter "3" via the keyboard; the menu will now request the number of the desired stored program:

```
ENTR STRD PGM NO. ---
```

- 3) entering a valid number will result in the RS-680 memories being loaded with the specified program.

The Model RS-680 may now be operated in either the run or single step modes. Note that valid stored program numbers lie in the range from 000 through 999; however, the numbers 990 through 999 are reserved for Interface Technology verification programs. These stored programs may be called whether or not the stored program card is installed.

Note also that, once a stored program has been called, both the control parameters and the data may be modified by the user. However, the device will no longer remain in the stored program mode.

3.5.2 Programming

The Model RS-680 plug-in stored program card may be ordered as option number 660-005 and is supplied without EPROMs. This card is to be installed in card slot A4J1 as indicated on the Model RS-680 top assembly drawing 1001 1328 contained in Appendix C.

CAUTION

Removal or installation of the stored program card should not be done while power is applied to the Model RS-680. Personnel safety considerations recommend that the primary power cord be disconnected from the unit's rear panel, while installing or removing the card.

The card is capable of containing eight 24 pin EPROMs as illustrated on the card's assembly and logic diagram drawing 10011130-002 contained in Appendix D. The EPROMs are assigned component designations of U1 - U8 and any of the following 5 volt EPROM types may be used for all EPROMs (450 nsec access maximum):

- a) Intel 2758, (1Kx8)
- b) Intel 2716, (2Kx8)
- c) Intel 2732, (4Kx8)
- d) Texas Instr. 2516, (2Kx8)

Component platform U9 must be prepared in accordance with the notes on drawing 10011130 in order to accommodate the EPROM type being used. The EPROMs are assigned the hexadecimal address space from '2000 to '7FFF relative to the Model RS-680's microprocessor. The following represents the resultant address assignments for each of the EPROMs:

EPROM ADDRESS ASSIGNMENTS

EPROM LOCATION	EPROM TYPE		
	2758	2716/2516	2732
U5	'2000	'2000	'2000
U6	'2400	'2800	'3000
U7	'2800	'3000	'4000
U8	'2C00	'3800	'5000
U1	'3000	'4000	'6000
U2	'3400	'4800	'7000
U3	'3800	'5000	-----
U4	'3C00	'5800	-----

The EPROMs must be programmed externally to the Model RS-680 and must contain both an EPROM directory of all stored programs and the control parameters and data for each stored program.

The directory is assumed to start at location '2000; i.e., the EPROM containing the directory must be installed in location U5. Each stored program requires 4 bytes in the directory. The first two bytes specify the program number, while the second two bytes specify the location in the EPROMs where the actual stored program starts. The programs need not

be listed in any particular sequence in the directory. The end of the directory must be identified by the delimiter "FF" which happens to be the unprogrammed state of the EPROMs. It is recommended that the user leave spare locations at the end of his directory, in order that other programs may be added at a later date.

Each stored program consists of the following:

- a) Two bytes which specify the last EPROM location used by the particular stored program.
- b) Twelve control bytes which contain all the information required to define the parameters in the CONTROL display.
- c) As many bytes of data/time as the program requires, starting with data word/bit number 1 in the 15th byte of the stored program EPROM contents.

The formats of the EPROM contents are summarized in tables 3.1 and 3.2.

TABLE 3.1
STORED PROGRAM EPROM DATA FORMAT

	EPROM ADDRESS	EPROM DATA	COMMENTS
Directory Start	'2000	0n	MSD of program number nnn. 000 ≤ nnn ≤ 989 (BCD).
	'2001	nn	LSDs " " " "
Directory	'2002	aa	MSB of first EPROM address where program number nnn resides (HEX)
	'2003	aa	LSB " " " "
	'2004	0n	directory data for program number nnnn
	'2005	nn	
	'2006	bb	
	'2007	bb	
Directory End	'x-4	0p	directory data for program number ppp
	'x-3	pp	
	'x-2	cc	
	'x-1	cc	
Program nnn Start	'x	'FF	designates end of directory
Control	'aaaa	AA	MSB of last EPROM address where program nnn resides (HEX)
	+1	AA	LSB " " " "
	+2	PC	mode control(P) and number of channels(C) (ref. table 3.2)
	+3	00	MSDs of number of words/bits per channel " " " "
	+4	NN	
	+5	NN	MSD's of sync word/bit number (BCD)
	+6	NN	
	+7	00	LSDs " " " "
	+8	SS	MSDs of number of pattern repetitions (BCD)
	+9	SS	
	+10	RR	LSDs of number of pattern repetitions " " " "
	+11	RR	
	+12	0M	Clock period multiplier (ref. table 3.3)
	+13	TT	MSDs of clock period digits (ref. table 3.3)
		TT	LSDs " " " "

irrelevant in continuous mode
irrelevant in TIMING SIMULATOR
or External Clock
WORD GENERATOR
MODES

TABLE 3.1 (continued)
STORED PROGRAM EPROM DATA FORMAT

EPROM ADDRESS	EPROM DATA	COMMENTS
'aaaa+14 +15	DD	Reference table 3.4 for Word Generator 16 channel
	DD	
'AAAA		Reference table 3.5 for Timing Simulator
	DD	

Data

 Program end

TABLE 3.2
STORED PROGRAM EPROM DATA FORMAT
MODE CONTROL AND NUMBER OF CHANNELS

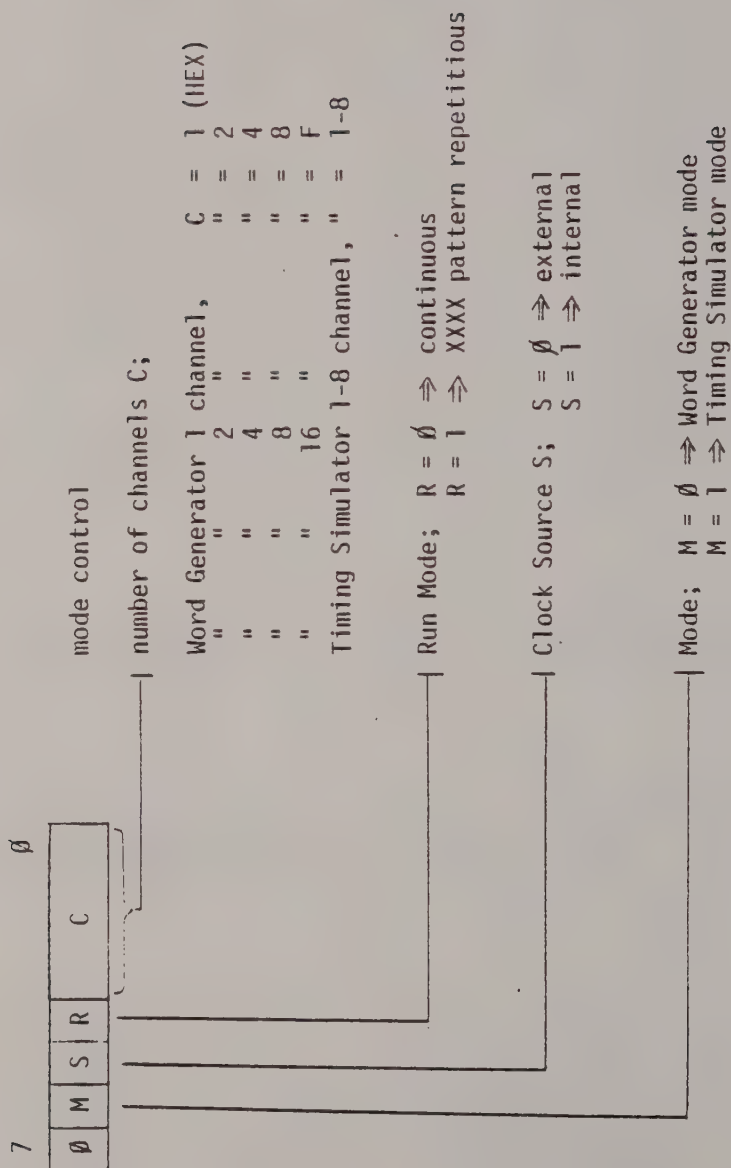


TABLE 3.3
STORED PROGRAM EPROM DATA FORMAT
CLOCK PERIOD MULTIPLIER AND DIGITS

7	0
0	M

clock period multiplier; $M = C_{(HEX)} \Rightarrow nSec$

$M = D_{(HEX)} \Rightarrow uSec$

$M = E_{(HEX)} \Rightarrow mSec$

7	0
T	T
T	T

MSDs of clock period (BCD) 3 digits +
LSDs of clock period (BCD) decimal point.

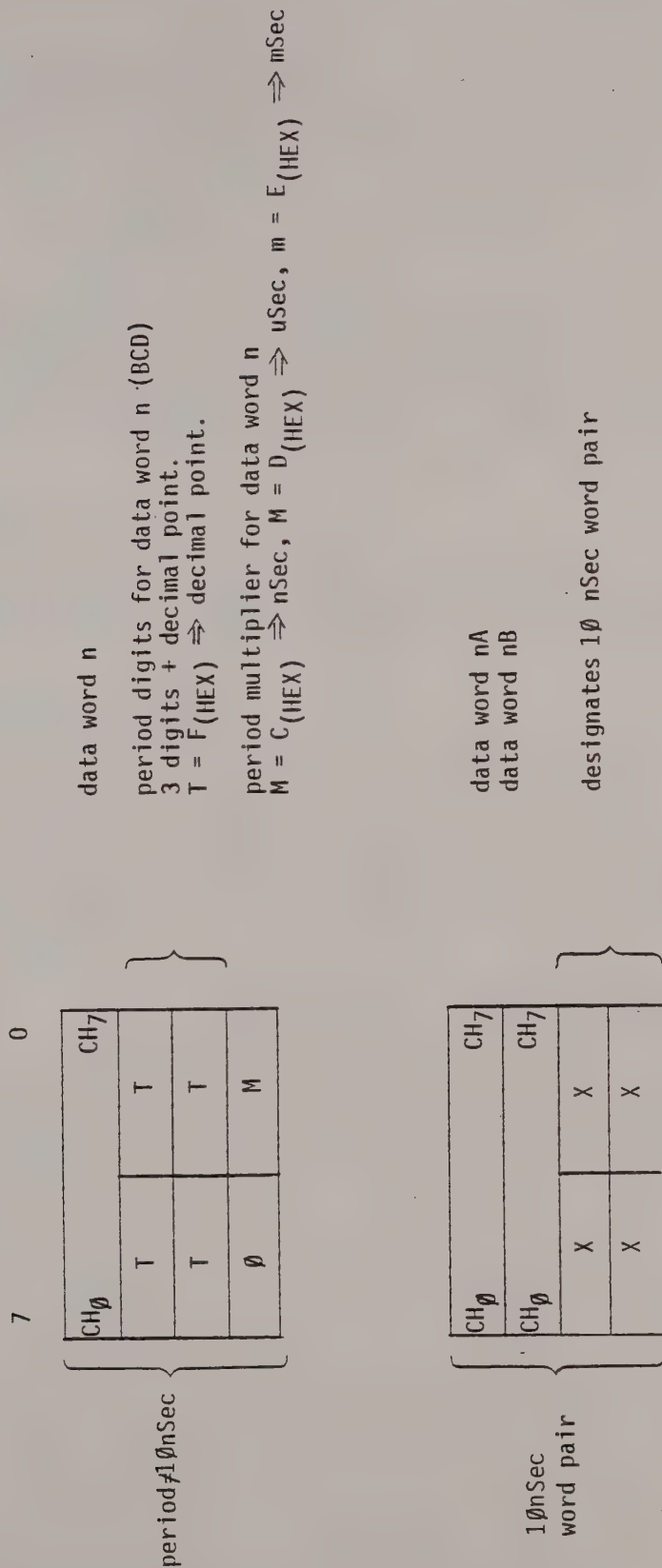
NOTE 1: $T = F_{(HEX)} \Rightarrow$ decimal point.

NOTE 2: clock period is irrelevant in Timing Simulator
and external clock Word Generator modes.

TABLE 3.4
STORED PROGRAM DATA FORMATS
WORD GENERATOR DATA

7	0	
CH ₀	CH ₇	16 channel; each data word requires 2 bytes
CH ₈	CH _F	
CH ₀	CH ₇	8 channel; each data word requires 1 byte
CH ₀	CH ₃ CH ₀	4 channel; 2 data words per byte.
n	n+1n+2n+3n+4n+5n+6n+7	2 channel; 8 data words per 2 bytes
n	n+1n+2n+3n+4n+5n+6n+7	
n	n+1n+2n+3n+4n+5n+6n+7	1 channel; 8 data bits per byte

TABLE 3.5
STORED PROGRAM DATA FORMAT
TIMING SIMULATOR DATA AND TIME



IV REMOTE CONTROL OPERATION

This section describes the operation of the Model RS-680 while under remote control from one of the following optional interfaces:

- a) Card Reader
- b) IEEE Std 488-1978
- c) RS-232C/TTY

These interfaces provide various degrees of control of the Model RS-680. The card reader simply enables the operator to load the data/time memory and define all parameters. The IEEE Std 488-1978 and RS-232C/TTY interfaces permit the loading and reading of the memory, definition of the parameters, starting and stopping the unit and reading the status of the Model RS-680.

4.1 CARD READER

The card reader option (no. 660-003) consists of an optical card reader into which pencil marked cards may be inserted to load the Model RS-680. This provides a hard copy medium for loading frequently used programs.

4.1.1 Card Programming

The card reader cards must be marked with binary data, a mark representing a binary "1" and no mark representing a binary "0". The most reliable method of programming a set of cards is to first load the Model RS-680 manually, run the program, verifying correct operation, and then translate the parameters and data/time directly from the device to cards. Note that a soft lead (#2) pencil should be used to mark the cards and that any erasures must be performed completely. Cards may be categorized as follows:

- a) control cards: used to load CONTROL parameters
- b) Word Generator data cards: 16,8,4,2 and 1 channel
- c) Timing Simulator data and time cards

Figure 4.1 depicts the blank cards, showing valid areas. The formats for the three different types of cards are defined by figures 4.2 through 4.8.

Figure 4.1
CARD READER CARD FORMATS

[illegible][illegible]

The number of the first word or bit on any data or data/time card is directly related to the card number (specified by card row numbers 2 & 3) and may be calculated, if required, using the following table or formula:

DATA WORD/BIT ORGANIZATION FOR CARD PROGRAMMING

DATA CARD NUMBER	DATA CARD FIRST WORD/BIT NUMBER					TIMING SIMULATOR
	W.G. 16 CHANNEL	W.G. 8 CHANNEL	W.G. 4 CHANNEL	W.G. 2 CHANNEL	W.G. 1 CHANNEL	
1	1	1	1	1	1	1
2	17	33	65	129	257	9
3	33	65	129	257	513	17
4	49	97	193	385	769	25
5	65	129	257	513	1025	33
6	81	161	321	641	1281	41
7	97	193	385	769	1537	49
8	113	225	449	897	1793	57
9	129	257	513	1025	2049	65
10	145	289	577	1153	2305	73
11	161	321	641	1281	2561	81
12	177	353	705	1409	2817	89
13	193	385	769	1537	3073	97
14	209	417	833	1665	3329	105
15	225	449	897	1793	3585	113
16	241	481	961	1921	3841	121
17	--	--	--	--	--	129
18	--	--	--	--	--	137
19	--	--	--	--	--	145
20	--	--	--	--	--	153
21	--	--	--	--	--	161
22	--	--	--	--	--	169
23	--	--	--	--	--	177
24	--	--	--	--	--	185
25	--	--	--	--	--	193
26	--	--	--	--	--	201
27	--	--	--	--	--	209
28	--	--	--	--	--	217
29	--	--	--	--	--	225
30	--	--	--	--	--	233
31	--	--	--	--	--	241
32	--	--	--	--	--	249

NOTE: The number of the first word/bit (b_F) on any data card may be calculated using the following formula:

$$b_F = 1 + \left[\frac{256}{C} (N_C - 1) \right]$$

where b_F = number of first word/bit on card

C = number of channels (substitute 32 for TIMING SIMULATOR)

N_C = data card number

This enables the user to load the cards into the card reader in any order but necessitates that the data, on all cards, commences from and ends at the specified boundaries.

No extraneous marks should be present below the top 7/8 inch of the card, on either the front or the rear.

Figure 4.2
CARD READER CONTROL CARD FORMAT

CARD ROW
NUMBER

	7	6	5	4	3	2	1	0
1	Ø	M	C	R	MSB			LSB

I.D. BYTE

NO. OF CHANNELS; WORD GENERATOR-1,2,4,8,F(1)
TIMING SIMULATOR 1-8

RUN MODE; R = Ø ⇒ CONTINUOUS
R = 1 ⇒ REPETITIOUS

CLOCK SOURCE; C = Ø ⇒ EXTERNAL
C = 1 ⇒ INTERNAL

MODE; M = Ø ⇒ WORD GENERATOR MODE
M = 1 ⇒ TIMING SIMULATOR MODE

DEFINES CONTROL CARD

2	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
3	MSD							
4					LSD			
5	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
6	MSD							
7					LSD			
8	MSD							
9					LSD			
10	Ø	Ø	Ø	Ø				
11	MSD							
12					LSD			

WORDS/BITS PER CHANNEL (BCD)

SYNC WORD/BIT (BCD)

NUMBER OF REPETITIONS (BCD)
(Irrelevant in Continuous Mode)

CLOCK PERIOD MULTIPLIER; C_(HEX) ⇒ nSec
D_(HEX) ⇒ uSec; E_(HEX) ⇒ mSec

CLOCK PERIOD DIGITS (BCD)
1111 ⇒ DECIMAL POINT

NOTE: Rows 10, 11 and 12 are not used in TIMING SIMULATOR or EXTERNAL CLOCK, WORD GENERATOR Modes.

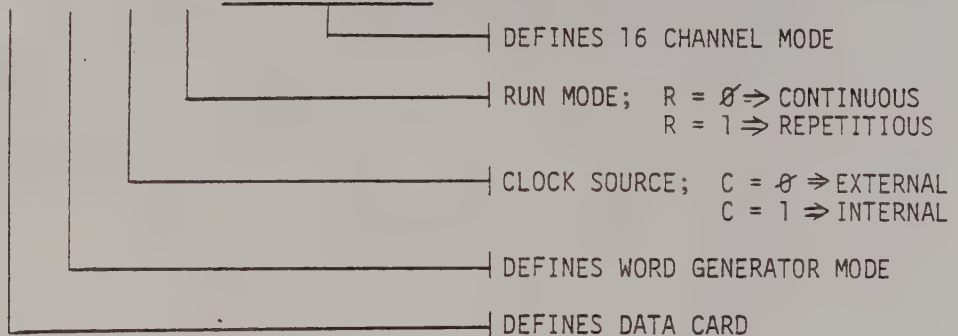
Figure 4.3
16 CHANNEL WORD GENERATOR DATA CARD FORMAT

CARD ROW
NUMBER

1

1	0	C	R	1	1	1	1
---	---	---	---	---	---	---	---

I.D. BYTE



2

0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---

3

MSD

LSD

DATA CARD NUMBER (BCD)

4

CH0	CH7
-----	-----

1st DATA WORD OF PAGE

5

CH8	CHF
-----	-----

6

CH0	CH7
-----	-----

2nd DATA WORD OF PAGE

7

CH8	CHF
-----	-----

32

CH0	CH7
-----	-----

15th DATA WORD OF PAGE

33

CH8	CHF
-----	-----

34

CH0	CH7
-----	-----

16th (LAST) DATA WORD OF PAGE

35

CH8	CHF
-----	-----

Figure 4.4
8 CHANNEL WORD GENERATOR DATA CARD FORMAT

CARD ROW
NUMBER

1

1	0	C	R	1	0	0	0
---	---	---	---	---	---	---	---

I.D. BYTE

DEFINES 8 CHANNEL MODE

RUN MODE; R = 0 ⇒ CONTINUOUS
R = 1 ⇒ REPETITIOUS

CLOCK SOURCE; C = 0 ⇒ EXTERNAL
C = 1 ⇒ INTERNAL

DEFINES WORD GENERATOR MODE

DEFINES DATA CARD

2

0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---

3

MSD

LSD

DATA CARD NUMBER (BCD)

4

CH0

CH7

1st DATA WORD OF PAGE

5

CH0

CH7

2nd DATA WORD OF PAGE

34

CH0

CH7

31st DATA WORD OF PAGE

35

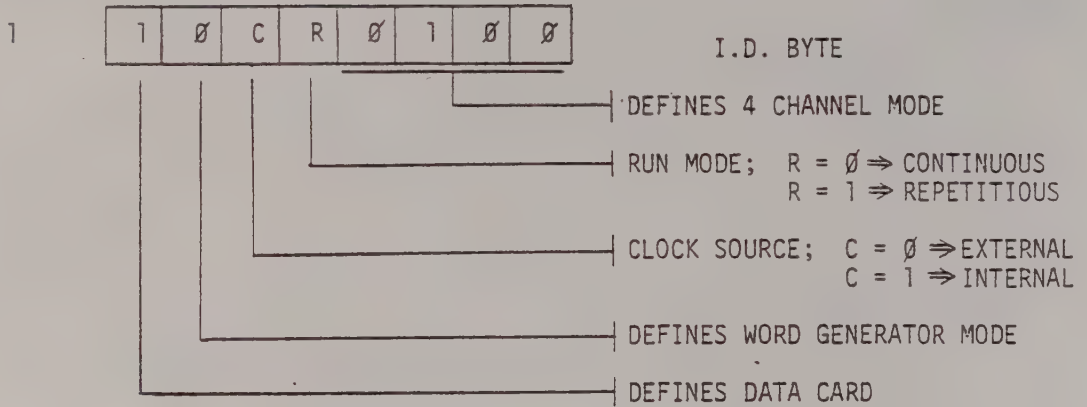
CH0

CH7

32nd DATA WORD OF PAGE

Figure 4.5
4 CHANNEL WORD GENERATOR DATA CARD FORMAT

CARD ROW
NUMBER



2	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
3	MSD				LSD			
4	CHØ WORD #1 CH3				CHØ WORD #2 CH3			
5	CHØ WORD #3 CH3				CHØ WORD #4 CH3			

DATA CARD NUMBER (BCD)

1st and 2nd DATA WORD OF PAGE

3rd and 4th DATA WORD OF PAGE

34	CHØ WORD#61 CH3				CHØ WORD#62 CH3			
35	CHØ WORD#63 CH3				CHØ WORD#64 CH3			

61st and 62nd DATA WORD OF PAGE

63rd and 64th DATA WORD OF PAGE

Figure 4.6
2-CHANNEL WORD GENERATOR DATA CARD FORMAT

CARD ROW
NUMBER

1

1	0	C	R	0	0	1	0
---	---	---	---	---	---	---	---

I.D. BYTE

DEFINES 2 CHANNEL MODE

RUN MODE; R = 0 ⇒ CONTINUOUS
R = 1 ⇒ REPETITIOUS

CLOCK SOURCE; C = 0 ⇒ EXTERNAL
C = 1 ⇒ INTERNAL

DEFINES WORD GENERATOR MODE

DEFINES DATA CARD

2

0	0	0	0	MSD			
---	---	---	---	-----	--	--	--

3

MSD				LSD			
-----	--	--	--	-----	--	--	--

DATA CARD NUMBER (BCD)

4

1	2	3	4	5	6	7	8
---	---	---	---	---	---	---	---

CHANNEL 0 BIT NUMBERS 1 THRU 8 OF PAGE

5

1	2	3	4	5	6	7	8
---	---	---	---	---	---	---	---

CHANNEL 1 BIT NUMBERS 1 THRU 8 OF PAGE

34

121	122	123	124	125	126	127	128
-----	-----	-----	-----	-----	-----	-----	-----

CHANNEL 0 BIT NUMBERS 121 THRU 128 OF PG.

35

121	122	123	124	125	126	127	128
-----	-----	-----	-----	-----	-----	-----	-----

CHANNEL 1 BIT NUMBERS 121 THRU 128 OF PG.

Figure 4.7
SINGLE CHANNEL WORD GENERATOR DATA CARD FORMAT

CARD ROW
NUMBER

1

1	0	C	R	0	0	0	1
---	---	---	---	---	---	---	---

I.D. BYTE

DEFINES SINGLE CHANNEL MODE

RUN MODE; R = 0 ⇒ CONTINUOUS
R = 1 ⇒ REPETITIOUS

CLOCK SOURCE; C = 0 ⇒ EXTERNAL
C = 1 ⇒ INTERNAL

DEFINES WORD GENERATOR MODE

DEFINES DATA CARD

2

0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---

3

MSD				LSD			
-----	--	--	--	-----	--	--	--

DATA CARD NUMBER (BCD)

4

1	2	3	4	5	6	7	8
---	---	---	---	---	---	---	---

CHANNEL 0, BIT NUMBERS 1 THROUGH 8

5

9	10	11	12	13	14	15	16
---	----	----	----	----	----	----	----

CHANNEL 0, BIT NUMBERS 9 THROUGH 16

34

240	241	242	243	244	245	246	247
-----	-----	-----	-----	-----	-----	-----	-----

CHANNEL 0, BIT NUMBERS 240 THROUGH 247

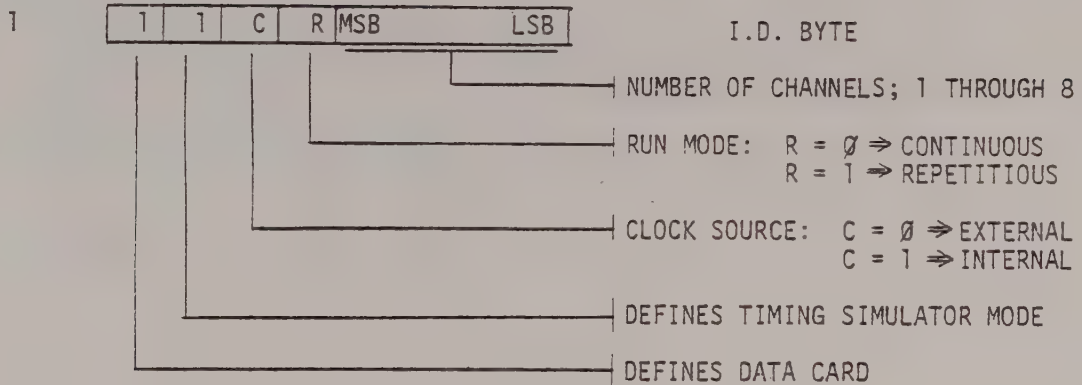
35

248	249	250	251	252	253	254	255	256
-----	-----	-----	-----	-----	-----	-----	-----	-----

CHANNEL 0, BIT NUMBERS 248 THROUGH 256

Figure 4.8
TIMING SIMULATOR DATA/TIME CARD FORMAT

CARD ROW
NUMBER



2	0	0	0	0	0	0	0	0
3	MSD				LSD			
4	CH ₀ CH ₇							
5	MSD							
6					LSD			
7	0	0	0	0				

DATA CARD NUMBER (BCD)

1st DATA WORD OF PAGE

1st WORD PERIOD DIGITS(BCD) NOTE: FOR 10/10
WORDS: ROW 5=B DATA WORD, ROW 6=UNUSED
1111 ⇒ DECIMAL POINT

1st WORD MULTIPLIER; C(HEX) ⇒ nSec,
D(HEX) ⇒ uSec, E(HEX) ⇒ mSec

32	CH ₀ CH ₇							
33	MSD							
34					LSD			
35	0	0	0	0				

8th DATA WORD OF PAGE

8th WORD PERIOD DIGITS(BCD) NOTE: FOR 10/10
WORDS: Row 33=B DATA WORD, ROW 34=UNUSED
1111 ⇒ DECIMAL POINT

8th WORD MULTIPLIER; C(HEX) ⇒ nSec,
D(HEX) ⇒ uSec, E(HEX) ⇒ mSec

4.1.2 Operation

The card reader connects to the Model RS-680's designated rear panel connector. The cards must be inserted, one at a time, into the card reader with the marked side down and should be released as soon as the drive engages the card. Do not force or assist the card. While the Model RS-680 is reading a card, all front panel controls are locked out. REMOTE CONTROL is not displayed on the CRT, as this is only a temporary condition. Note that the Model RS-680's CRT display will be modified, according to the most recently loaded card.

Once all of the cards have been loaded the device may be operated under local control (reference section 3).

4.2 IEEE STD 488-1978 CONTROLLER INTERFACE

The Model RS-680's IEEE controller interface is available as option number 680-001 and may be either factory or field installed.

4.2.1 Preparation For Use

Prior to attempting communication with the user's system controller, the desired device address must be selected by setting five dipswitches located on the rear panel of the RS-680 directly above the IEEE 488 connector. Depressing a switch to the "ON" position sets the corresponding address bit to a logical one. The address switches may be changed while power is applied to the unit; however, the front panel RESET switch must be depressed to complete the address reselection.

The Model RS-680's IEEE controller incorporates the following functions of IEEE Std 488-1978:

- SH1 : includes the source handshake function
- AH1 : includes the acceptor handshake function
- T6 : incorporates the non-extended talker function including serial poll
- L4 : includes the non-extended listener function
- SR0 : does not generate service request (SRQ)
- RL0 : does not incorporate remote selection functions using interface messages; instead uses device dependent data for selection of remote control; receipt of any data byte sets the RS-660 in remote; local control is achieved either upon receipt of an ASCII "L" data byte or upon depression of the front panel RESET key.
- PP0 : does not include parallel poll capability
- DC1 : incorporates device clear function (DCL,SDC)
- DT1 : incorporates device trigger function (GET)
- C0 : includes no controller capability

The interface option uses open-collector drivers on all signals.

4.2.2 Operation

All data communication with the Model RS-680 controller interfaces is accomplished using a limited set of ASCII characters. Control is accomplished using the characters K,L,N,P,Q,R,S,T,U,V,W,X,Y and Z. Hexadecimal data use the ASCII characters 0,1...9, A,...F. The ASCII comma is used as an instruction delimiter. All other ASCII characters are ignored. This enables the user to imbed a carriage return/line feed in his transmitted data for local page formatting.

When operating under remote control, the CRT display data does not reflect prior user remote programming until the RS-680 receives an ASCII "Q".

Table 4.1 provides a summary of the protocol for the RS-680 controller interfaces and is applicable to both the IEEE STD-488 and RS-232-C interfaces. Table 4.2 provides a detailed description of the controller interfaces' protocol.

TABLE 4.1
 PROTOCOL SUMMARY FOR CONTROLLER INTERFACES

<u>FUNCTION</u>	<u>INPUT/OUTPUT</u>		<u>FORMAT</u>
Update CRT	I	Q	
Return to Local Control	I	L	
Reset	I	R	
Read Unit Status	I	U	
	O		d CR/LF
Load Parameters	I		Pnw, c, bbbbbb, 1111, sssss, i, ttttm,
Read Parameters	I	Y	
	O		w, c, bbbbbb, 1111, sssss, i, ttttm, CR/LF
Load Word Gen. Data	I		Wc, aaaa, dddd, dddd, ..., dddd,
Read Word Gen. Data	I		Zaaaaa, nnnn,
	O		dddd, dddd, ..., dddd, CR/LF
Load Timing Sim. Data	I		Xaaaa, ddttttm, ..., ddttttm,
Read Timing Sim. Data	I		Vaaaa, nnnn,
	O		ddttttm, ddttttm, ..., ddttttm, CR/LF
Execute Fill	I		Naaaaa, bbbbbb, ccccc, nnnnn,
Read Stored Program Menu	I	M	
	O		nnn, nnn, . . ., nnn, CR/LF
Load Stored Program	I		Knnn,
Start/Stop	I	S	
Trigger	I	T	

Notes:

1. All characters are ASCII.

TABLE 4.2
DETAILED PROTOCOL DESCRIPTION
FOR CONTROLLER INTERFACES

UPDATE CRT

Control: Q

Updates the CRT to display current programming parameters.

RETURN TO LOCAL CONTROL

Control: L

Causes the unit to return to local control. Also resets machine and stops.

RESET

Control: R

Causes the following:

1. Stops the generator if running.
2. Resets Word Generator/Timing Simulator Memory to word/bit number 1.

READ UNIT STATUS

Control: U

Response: d CR/LF

- U = Read unit status control character
2 = Remote, programming mode (stopped)
3 = Remote, running

LOAD PARAMETERS

Control/Data:

P0w, c, bbbbb, 1111, sssss, i, ttttm,
P1w,
P2c,
P3 bbbbb,
P4 1111,
P5 sssss,
P6 i,
P7 ttttm,

w: Mode

- 1 = Word Generator
2 = Timing Simulator

c: Number of output channels

Word Generator - 1, 2, 4, 8, F (F used to specify 16 channels)

Timing Simulator - 1 through 8

TABLE 4.2
(CONTINUED)

LOAD PARAMETERS (Continued)

bbbb: Number of bits/words per channel (decimal).
llll: Number of pattern repeats, 1 - 4096; 0000 = continuous(decimal).
ssss: Sync word/bit (decimal).

i : Clock Source
1 = Internal
2 = External

tttm: Period and multiplier (Word Generator only)

Multiplier Coding

C = Nanoseconds; reference restrictions of paragraph 3.2.8.
D = Microseconds
E = Milliseconds

Comma: Used as instruction delimiter.

READ PARAMETERS

Control: Y

Response: w, c, bbbb, llll, ssss, i, tttm, CR/LF

Y: Read parameters control character.

Response data format same as "Load Parameter" format.

LOAD WORD GENERATOR DATA

Control/Data: Wc, aaaa, dddd, dddd, ..., dddd,

W: Load word generator control character.
c: Number of output channels - 1,2,4,8,F (F used to specify channels).
aaaa: First word or bit number to be loaded.
dddd: Data (hex); reference Table 4-3.
Comma: Used as parameter delimiter.

READ WORD GENERATOR DATA

Control: Zaaaa, nnnn,

Response Data: dddd, dddd, ..., dddd, CR/LF

Z: Read word generator control character.
aaaa: First word or bit number to be read.
nnnn: Number of 16 bit words (four ASCII digits) to be read; reference Table 4-3.
dddd: Data (hex); reference Table 4-3.
Comma: Used as instruction delimiter.

TABLE 4.2
(CONTINUED)

LOAD TIMING SIMULATOR DATA

Control/Data: Xaaaa, ddttttm, ..., ddttttm,
X: Load Timing Simulator control character.
aaaa: Number of first time interval to be loaded.
ddttttm: Data (hex); reference Table 4-4.
Comma: Used as instruction delimiter.

READ TIMING SIMULATOR DATA

Control: Vaaaa, nnnn,
Response Data: ddttttm, ddttttm, ..., ddttttm, CR/LF
V: Read Timing Simulator control character.
aaaa: Number of first time interval to be read.
nnnn: Number of intervals to be read (10/10 nsec intervals count as one).
ddttttm: Data (hex); reference Table 4-4.
Comma: Used as instruction delimiter.

EXECUTE FILL

Control: Naaaaa, bbbbbb, ccccc, nnnnn,
N: Execute fill control character.
aaaaa: First word/bit of data to be repeated (decimal).
bbbbbb: Last word/bit of data to be repeated (decimal).
ccccc: Number of times pattern must be repeated (decimal).
nnnnn: Number (decimal) of first word/bit where pattern is to be repeated.
Comma: Used as instruction delimiter.

READ STORED PROGRAM MENU

Control: M
Response: nnn, nnn, . . ., nnn, CR/LF
Outputs the program number (decimal) of all programs in the stored program EPROM card.

LOAD STORED PROGRAM

Control: Knnn,
K: Load stored program control character.
nnn: Stored program number (decimal - nnn $\neq$ 0)
Comma: Used as instruction delimiter.
This function transfers the desired stored program from the stored program EPROM card to the RS-680 generator.

TABLE 4.2
(CONTINUED)

START/STOP

Control: S

Causes the unit to change state between programming and running.

TRIGGER

Control: T

Applicable only for single cycle mode. A trigger causes the generator to repeat the basic data block according to the number of repetitions specified.

TABLE 4.3
WORD GENERATOR DATA CONFIGURATION

Number of
Channels

16	Channel No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
	Bit No.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

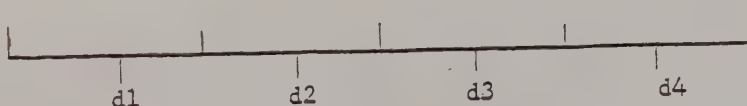
8	Channel No.	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
	Bit No.	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2

4	Channel No.	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
	Bit No.	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4

2	Channel No.	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Bit No.	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8

1	Channel No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bit No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Character

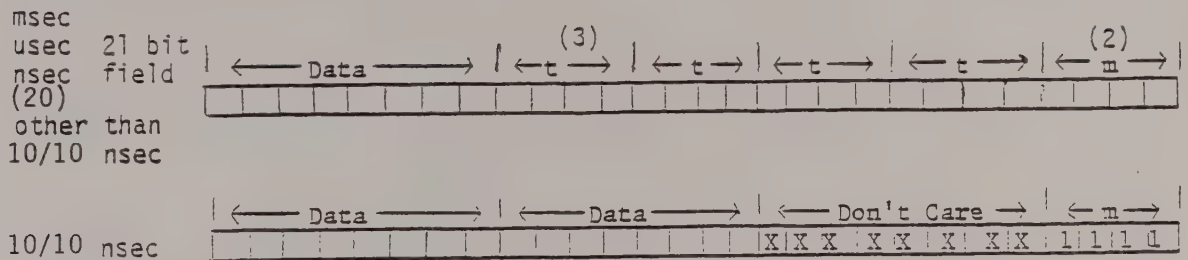


Notes:

- 1) All Word Generator data are formatted in hex for transfer over the interface; i.e., $0 \leq d \leq F$.

TABLE 4.4
TIMING SIMULATOR DATA CONFIGURATION

Multiplier



Notes:

- 1) All Timing Simulator data (d) is formatted in hex' i.e., $0 \leq d \leq F$.
Channel 0 is the left-most bit, channel 7 is the right-most.
- 2) Multiplier codes (ASCII).
 - C - nsec
 - D - usec
 - E - msec
 - F - 10/10
- 3) "tttt" consists of a maximum 3 BCD numbers and an optional decimal point.
Reference period resolution and range of SPECIFICATIONS, section 1.4.

4.2.3 Operating Example

Table 4.5 provides an example of remote programming the RS-680. The example program performs the following:

- a) Resets the unit.
- b) Transmits parameter table to unit.
- c) Transmits word generator data to unit.
- d) Places unit in run mode.
- e) Triggers the unit.
- f) Delays for 10.0288 seconds minimum to allow completion of 1567 patterns.
- g) Places the unit in programming mode.
- h) Returns the unit to local control.

Once all of the data is loaded into the RS-680, the test program is started. Note that the same control character is used to start and/or stop the unit.

Data that is underlined is transmitted from the RS-680.

TABLE 4.5
CONTROLLER INTERFACE
PROGRAMMING EXAMPLE

DATA	COMMENTS
R	: Resets the RS-680
P01,	: Sets up to load all parameters, word gen. mode.
8,	: Defines 8 output channels.
512	: Defines 512 bits per channel.
1567,	: Defines 1567 pattern repeats.
390,	: Defines sync address of 390.
1,	: Internal clock source.
12.5D,	: Defines clock period 12.5 us.
Q,	: Updates display.
W81,	: Sets up to load word gen. data starting at word 1.
4815,	: Word 1 and 2
551F,	: Word 3 and 4
FEF7,	: Word 5 and 6
FFFF,	: Word 7 and 8
.	
.	
.	
4111,	: Word 511 and 512.
S	: Places unit in run mode.
T	: Triggers unit
.	} Delay
.	
.	
.	
S	: Places unit to local control.
L	: Returns unit to local control.

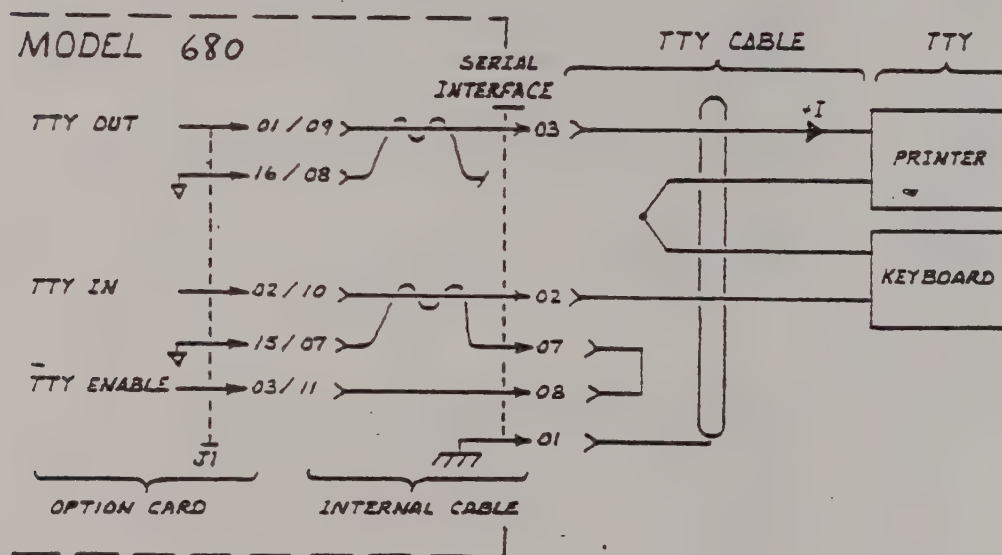
4.3 RS-232C/TTY CONTROLLER INTERFACE

The Model RS-680's RS-232-C controller interface is available as option number 680-002 and is a factory installed option.

4.3.1 Preparation For Use

The Model RS-680's rear panel connector, designated as SERIAL INTERFACE, is configured to connect to the cable of an RS-232-C terminal. Alternately, the RS-680 may be used as an RS-232C terminal by connecting the supplied terminal cable to the SERIAL INTERFACE connector and connecting the other end to the user's calculator or computer. The supplied cable is end interchangeable.

A teletype (TTY) may also be connected to the SERIAL INTERFACE connector. The following diagram illustrates the TTY cable construction:



Note that the internal RS-680 cable which plugs into the option card must be rotated 180° for TTY operation, such that pin 09 of the cable plugs into pin 01 of card socket J1.

Prior to attempting communication, the transmission baud rate must be selected by setting the rotary switch located on the RS-680's rear panel. The correspondence between baud rate and the switch positions is as follows:

<u>SWITCH POSITION</u>	<u>BAUD RATE</u>	<u>NO. OF BITS STOP BITS</u>
0	110	2
1	150	1
2	300	1
3	600	1
4	1200	1
5	2400	1
6	4800	1
7	9600	1
8 and 9	Invalid	-

The baud rate may be changed while power is applied. Following reselection of the baud rate while power is applied, depress the front panel RESET key to re-initialize the interface.

The RS-232-C interface option is a data channel implementation only.

The serial data format consists of the following:

- a) One start bit
- b) Seven data bits (LSB first)
- c) One parity bit, transmitted false, received "DON'T CARE"
- d) One stop bit (other than 110 baud), two stop bits at 110 baud.

The Model RS-680's RS-232-C interface does not ECHO transmit the received characters and therefore would normally be connected to a half-duplex terminal. The interface option does not delay when switching between the transmit and receive modes.

The selectable baud rates listed above represent only the valid character transmission rates and not the execution rates of the various RS-680 commands. Except for three functions, the commands of the RS-680 are executed within 3 msec. This implies that the maximum rate is 2400 baud if null pads are not inserted between commands. The update CRT function ("Q") requires 75 msec to execute. The load stored program ("K") and execute fill ("N") functions require variable execution times, dependent on the length of their required task. The user is able to sense the busy state by simply requesting status ("U") and waiting for a response. The RS-680 will not respond with a status until it has completed the last task.

4.3.2 Operation

Refer to sections 4.2.2 and 4.2.3 for a description of the controller interface operation and an operating example.

V. EXTERNAL OSCILLATOR OPERATION

5.1 INTRODUCTION

In order to synchronize the Model RS-680 to an externally generated system clock, the unit may be operated, in any mode, using an external, 100 MHz, TTL oscillator. The signal presented to the External Oscillator input BNC, which is located on the unit's rear panel, should have a 50% duty cycle and the source should be capable of providing valid TTL levels, into a 50 Ω termination, which is internal to the Model RS-680.

5.2 CONFIGURATION INSTRUCTIONS

The unit may be configured for external oscillator operation, by performing the following steps:

- 1) Disconnect the primary power cord from the rear panel of the Model RS-680.
- 2) Remove the four, top cover securing screws and withdraw the cover.
- 3) Remove the three screws, which secure the upper logic panel, A2 (adjacent to the power supply) and raise the panel to a vertical position. Reference drawing number 1001 1328. The lower logic panel (A3) should now be visible.
- 4) Locate and transpose the internal oscillator module and the external oscillator cable mounting platform. Reference drawing number 1001 1338. CAUTION: The internal oscillator module must be installed, such that pins 1 and 14 of the module mate with pins 2 and 15 respectively, of the appropriate I.C. socket. In addition, the Model RS-680, when delivered, is configured for internal oscillator operation; i.e. with the internal oscillator module and the external oscillator cable mounting platform installed in locations U6E and U11E respectively. Configuring the unit, for external oscillator operation, will result in the internal oscillator module and the external oscillator, cable mounting platform being installed in locations U11E and U6E respectively.
- 5) Return the upper logic panel (A2) to its original position and reinstall the three retaining screws.
- 6) Replace the top cover and associated retaining screws.

- 7) Connect the external oscillator BNC (J8), on the rear panel to the external oscillator source, via 50 Ω coaxial cable and reapply power to the unit.

NOTE: When operating the Model RS-680 with an external oscillator, all programmed periods are directly proportional to the period of the external oscillator signal. Hence, if the frequency (F HZ) of the external oscillator signal is not equal⁰ to 100 Mhz, the true period (t_o) of any programmed period (t_p) is given by the following equation:

$$t_o = \frac{t_p \times 10^8}{F_o} \text{ Sec.}$$

APPENDIX A

REAR PANEL I/O OPTION

SIGNAL LISTING

Rear Panel I/O Connector (J10)

SIGNAL	MNEMONIC	SIGNAL PIN NO.	RETURN PIN NO.
DATA OUTPUT CHANNEL 0	CH0+	25S	25G
DATA OUTPUT CHANNEL 1	CH1+	24S	24G
DATA OUTPUT CHANNEL 2	CH2+	23S	23G
DATA OUTPUT CHANNEL 3	CH3+	22S	22G
DATA OUTPUT CHANNEL 4	CH4+	21S	21G
DATA OUTPUT CHANNEL 5	CH5+	20S	20G
DATA OUTPUT CHANNEL 6	CH6+	19S	19G
TTL LEVEL STATUS INDICATOR	TTLEV+	18S	18G
DATA OUTPUT CHANNEL 7	CH7+	17S	17G
DATA OUTPUT CHANNEL 8	CH8+	16S	16G
DATA OUTPUT CHANNEL 9	CH9+	15S	15G
ECL LEVEL STATUS INDICATOR	ECLLEV+	14S	14G
DATA OUTPUT CHANNEL A	CHA+	13S	13G
DATA OUTPUT CHANNEL B	CHB+	12S	12G
DATA OUTPUT CHANNEL C	CHC+	11S	11G
VARIABLE LEVEL STATUS IND.	VARLEV+	10S	10G
DATA OUTPUT CHANNEL D	CHD+	09S	09G
DATA OUTPUT CHANNEL E	CHE+	08S	08G
DATA OUTPUT CHANNEL F	CHF+	07S	07G
SYNC BIT 1 OUTPUT	SNC1	06S	06G
PROGRAM SYNC OUTPUT	SNCP-	05S	05G
GATED OUTPUT CLOCK	GOCLK-	04S	04G
GATED OUTPUT CLOCK	GOCLK+	03S	03G
EXTERNAL CLOCK INPUT	EXCLK+	02S	02G
EXTERNAL TRIGGER INPUT	EXTRG-	01S	01G

APPENDIX B

CARD READER INTERFACE SIGNAL LISTING

Rear Panel Connector (J6, CARD READER)

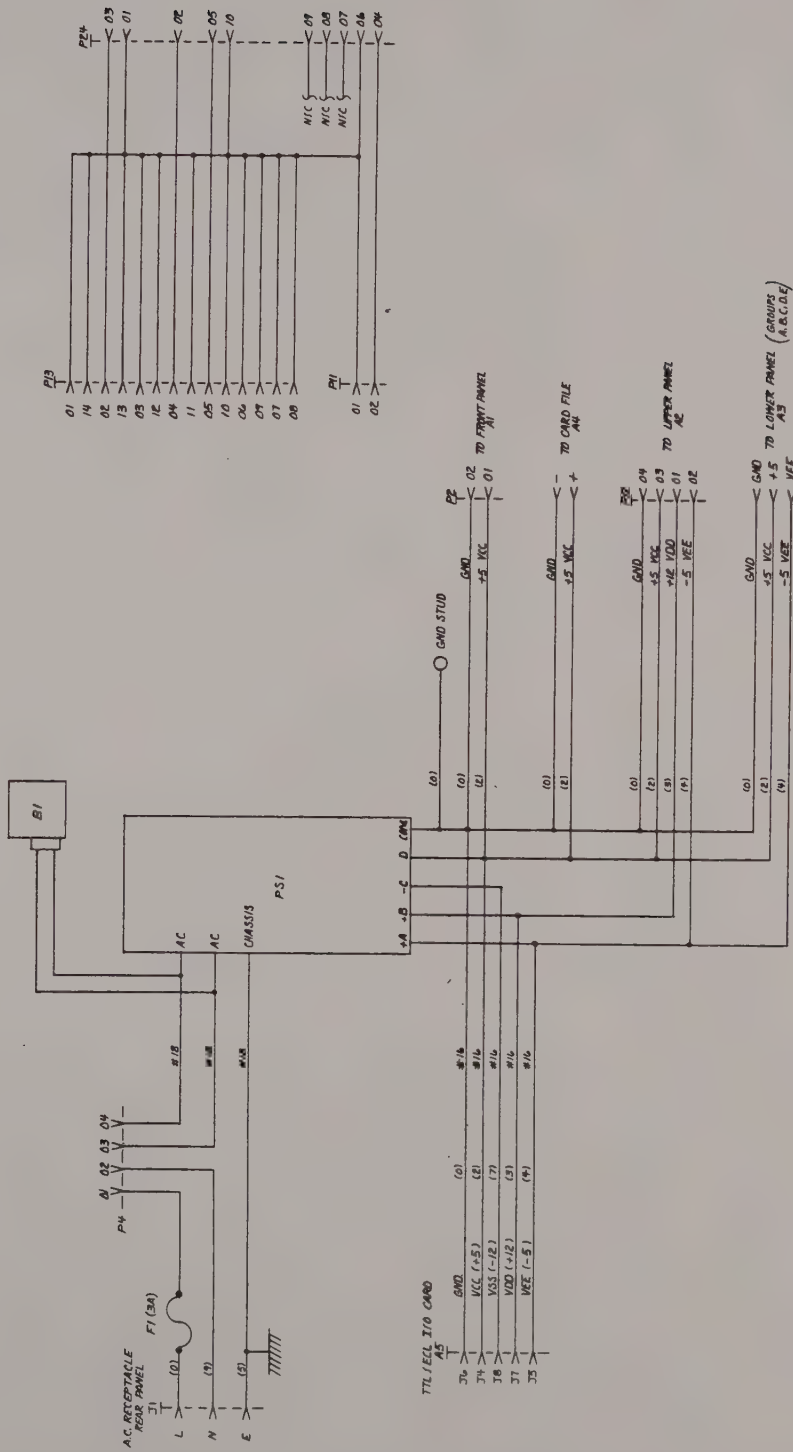
<u>SIGNAL</u>	<u>MNEMONIC</u>	<u>SIGNAL PIN NO.</u>
DATA 0	CRD0+	01
DATA 1	CRD1+	02
DATA 2	CRD2+	03
DATA 3	CRD3+	04
DATA 4	CRD4+	05
DATA 5	CRD5+	06
DATA 6	CRD6+	07
DATA 7	CRD7+	08
DATA STROBE	STOMI-	14
CARD PRESENT	CPOMD-	16
+5 VOLT SUPPLY	VCC	20
SIGNAL GROUND	GND	22

APPENDIX C
LOGIC DIAGRAMS

Top Assembly	1001 1328
Front Panel Assembly	1001 1317
Lower Logic Panel Assembly	1001 1338
TTL Logic Panel	1001 1321
Driver Board Assembly	1001 1326
IEEE Interface Card Assembly	1001 1134
Serial Interface Card Assembly	1001 1132
Stored Program Card Assembly	1001 1130

APPENDIX D

CRT HARNESS



A.C. POWERING AND CABLE HARNESSSES

Interface

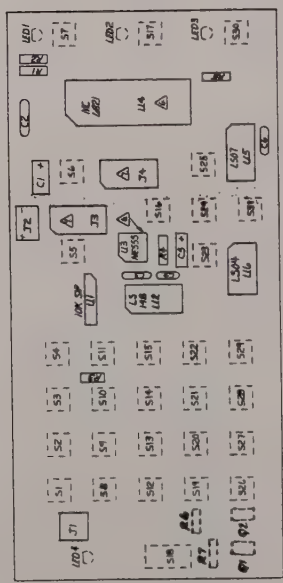
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 DRAWN BY: J.R.
 CHECKED BY: J.R.
 APPROVED BY: J.R.

RS-640 TYP ASSY

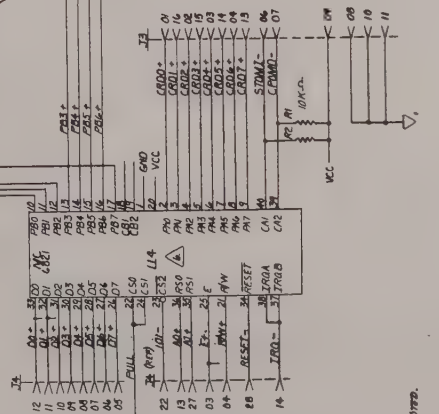
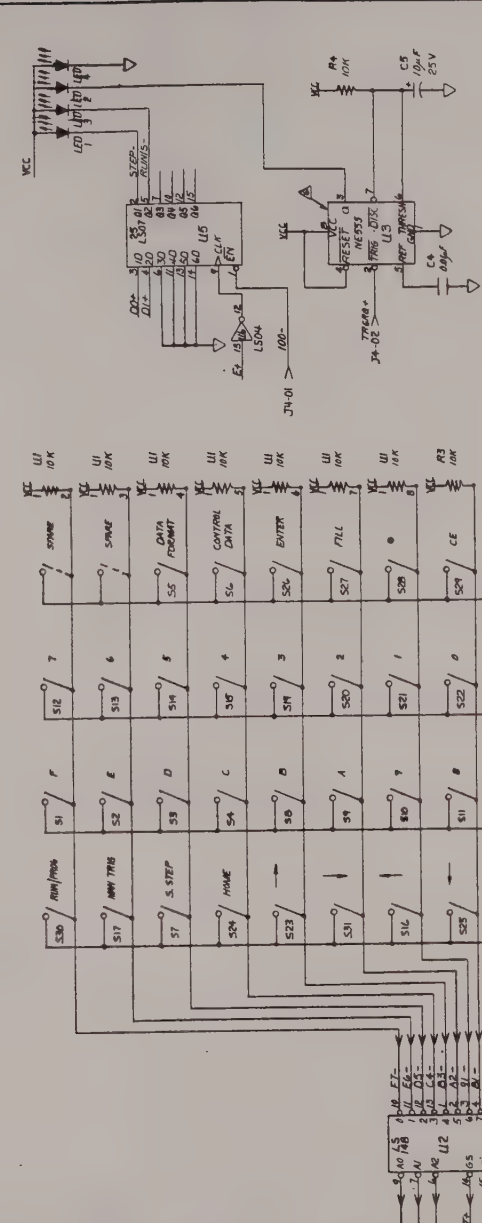
ENV. 2

55418 1001/1002

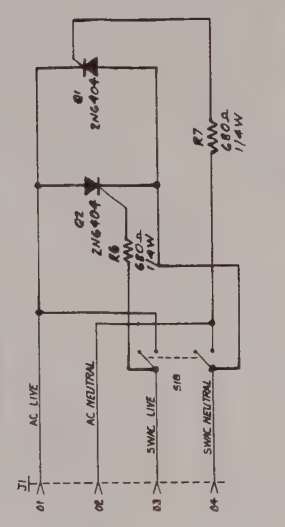
REV	DATE	BY	CHK	APP
1	10/13/77	W. J. P.		
2	10/13/77	W. J. P.		
3	10/13/77	W. J. P.		
4	10/13/77	W. J. P.		
5	10/13/77	W. J. P.		
6	10/13/77	W. J. P.		
7	10/13/77	W. J. P.		
8	10/13/77	W. J. P.		
9	10/13/77	W. J. P.		
10	10/13/77	W. J. P.		



PCB 1001194



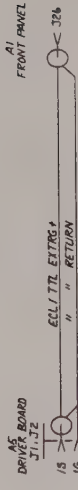
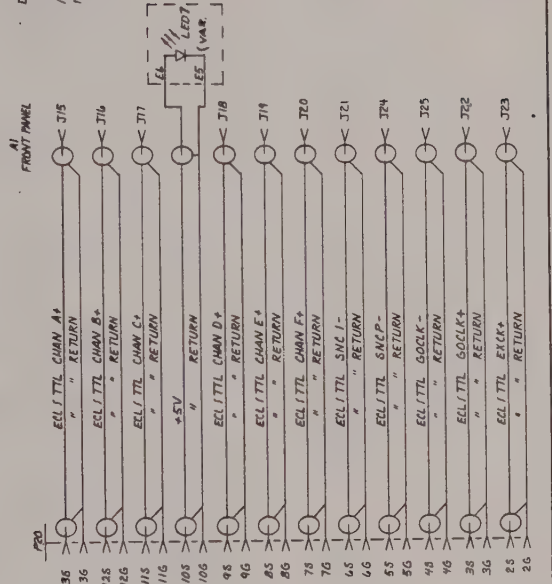
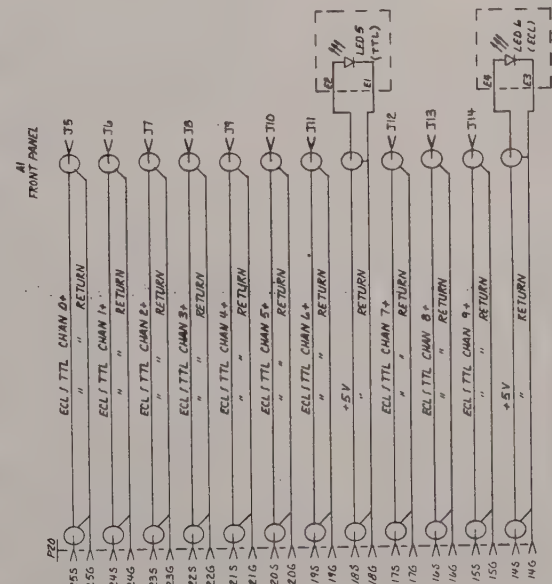
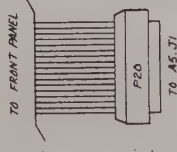
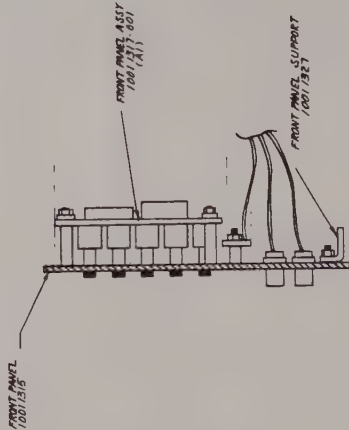
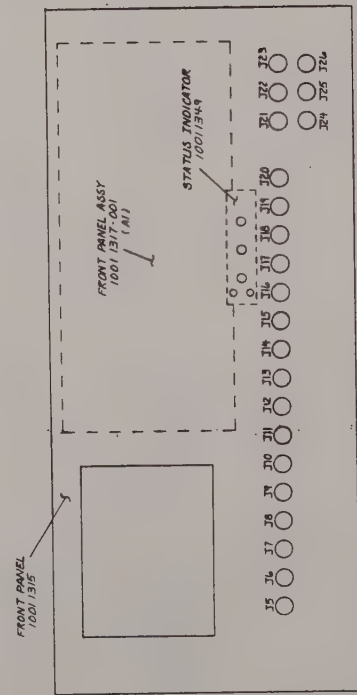
POWER SWITCH



- 1. N.P. DESIGNS HIGH PROFILE SOCKET.
- 2. ALL INTEGRATED CIRCUITS ARE SYNTH. UNLESS NOTED.
- 3. RESISTORS R1 THRU R5 10K 1/4W CARBON COMPOSITION
- 4. CAPACITORS C1 IS A .001UF AT 25V CERAMIC DISC
- 5. CAPACITORS C2, C3, C4 ARE .001UF AT 25V CERAMIC DISC
- 6. CAPACITORS C5, C6 ARE 10UF AT 25V ELECTROLYTIC

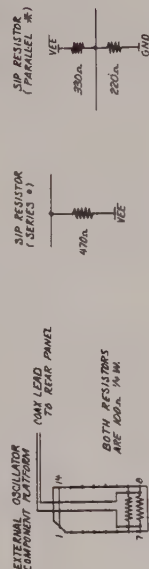
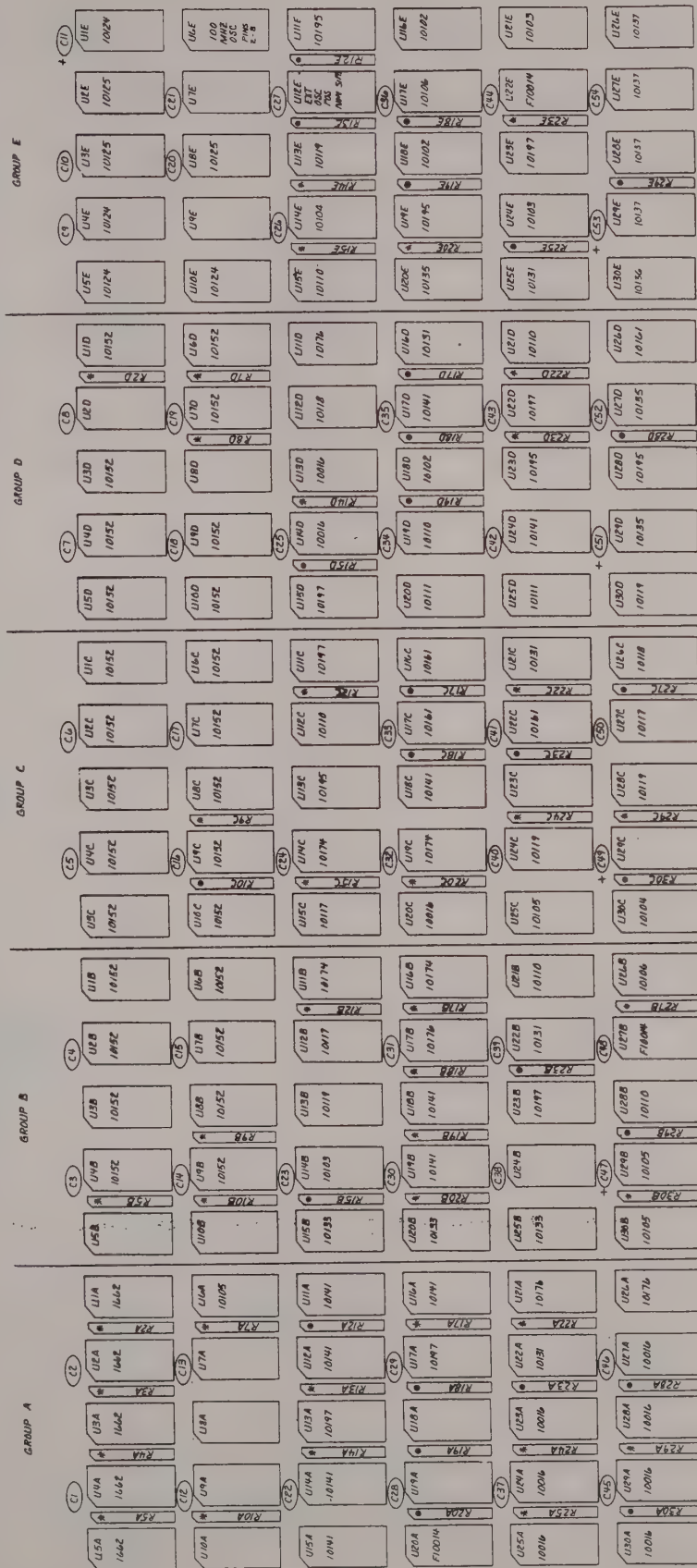
NOTES: UNLESS OTHERWISE SPECIFIED

Interface	
Model: NTS	Version: 1.0
Date: 10/13/77	Author: W. J. P.
Assembly: 1001194 FRONT PANEL	
Sheet: 1 of 2	5563
10011317	



REVISIONS		
LIN	DATE	APPR. DESCR.
1	4-4-68	DN C.G. #4-1008
2	8-3-68	J.A.D. COPY

interface TECHNOLOGY		APPROVED	DESIGNED BY <i>AK</i>
SCALE: <i>N73</i>	<i>WLD</i>		SYSTEM
DATE: <i>7/21/68</i>			
RS-680 ASST/LBO LWR LOGIC PANEL A3		<i>53615</i>	<i>10011336</i>
SHT. 1 OF 9			



5. CAPACITORS C1-C10, C12-C14, C48, C50, C52, C54 ARE 1µF AT 25V CERAMIC DISC

ALL CAPACITORS C11, C47, C49, C51, C53 ARE 10 μ F. AT 25V ELECTROLYTIC

7 SERIES SIP RESISTORS DESIGNATED BY ●

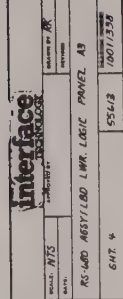
9. PARALLEL SIP RESISTORS DESIGNATED BY #

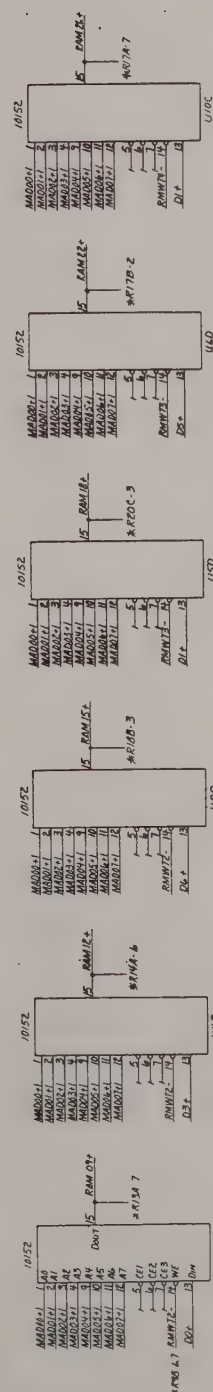
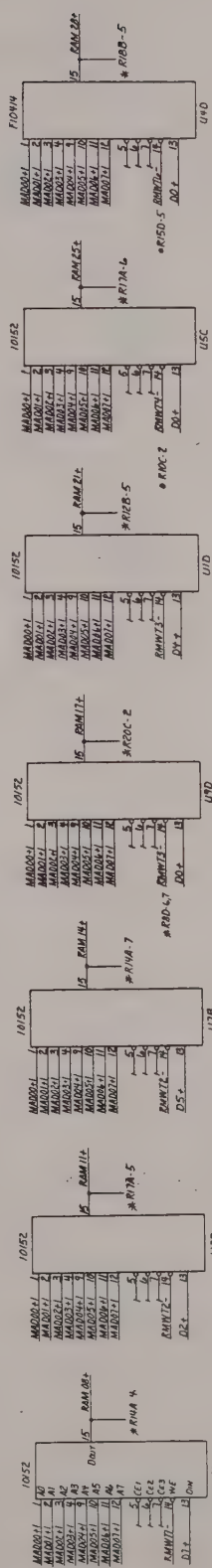
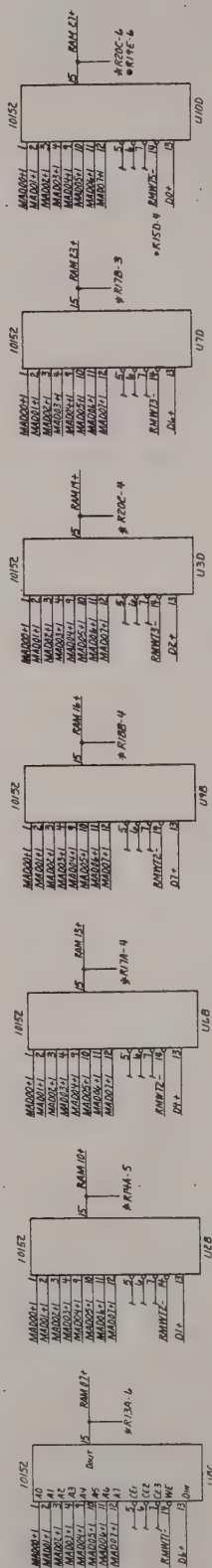
1. IF THE INSTALLED SIGN THAT PIN / AE TO MATCH WITH

PIN 2 OF SOCKET

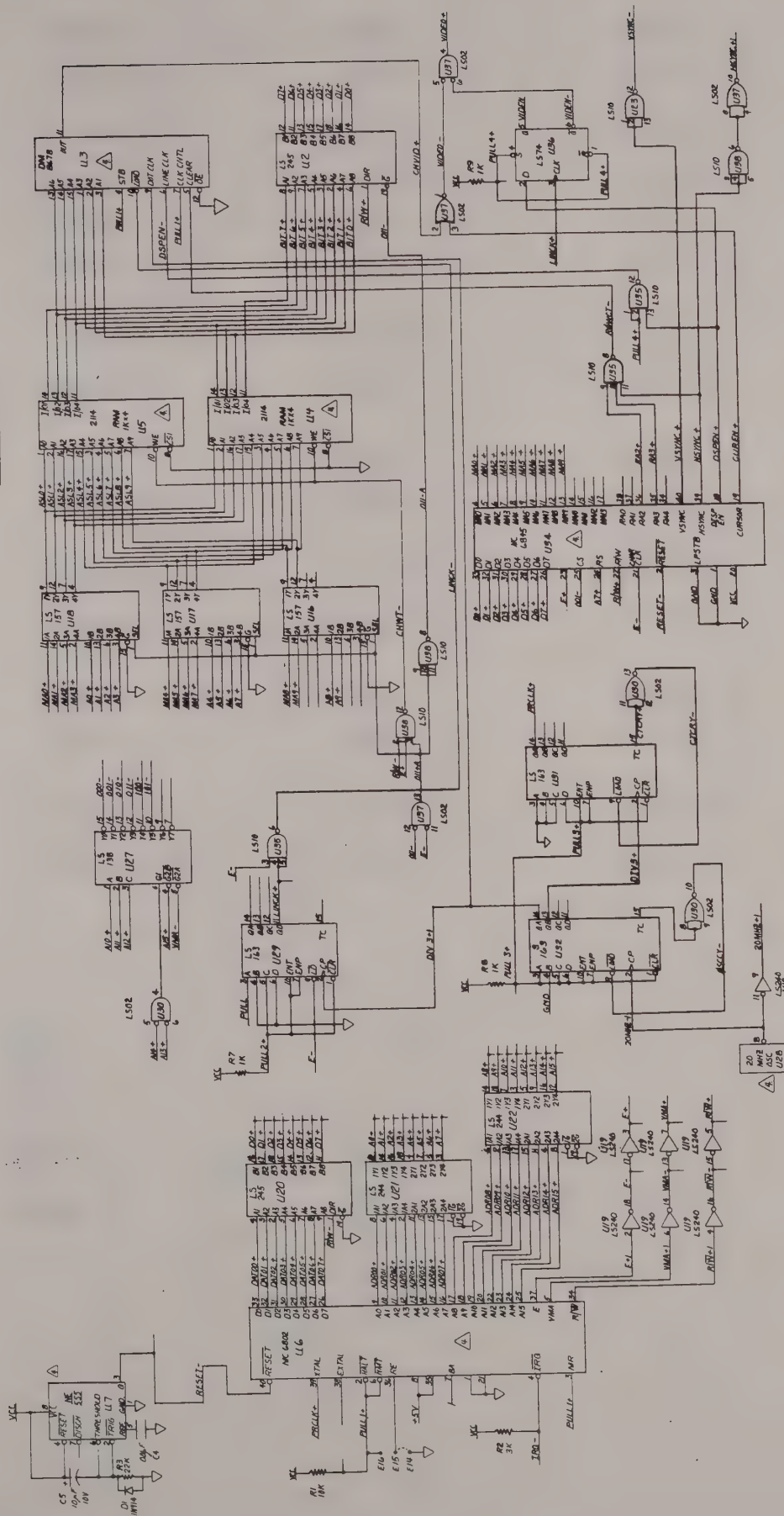
NOTES: UNLESS OTHERWISE SPECIFIED

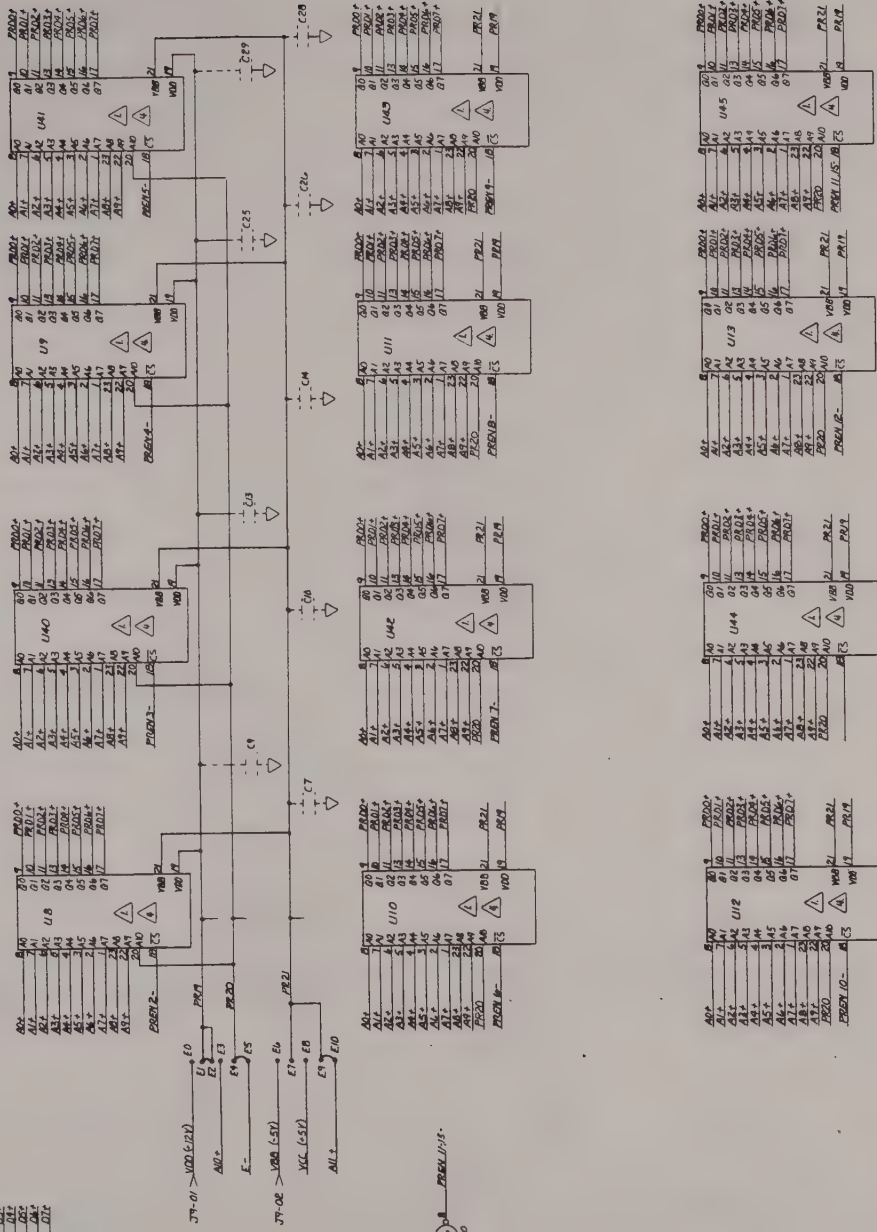
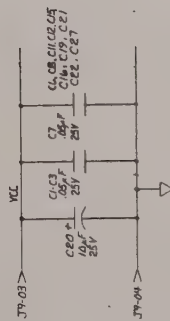
John Edward (Johnnie) B. 1891-1961





REFRESH MEMORY FOR CARRIAGE GENERATOR



**interface**
TECHNOLOGY

APPROVED BY _____

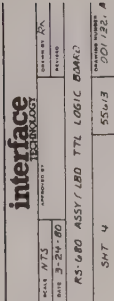
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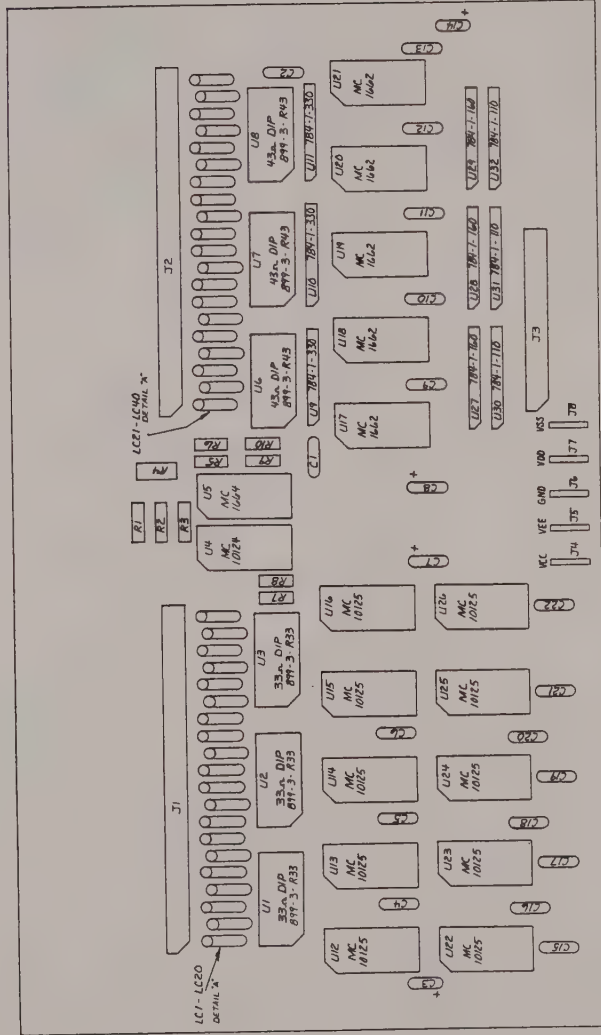
1051071

רמב"ם וד' רמב"ם

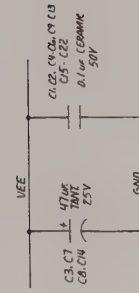
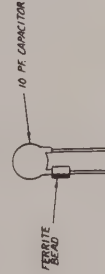
£1955

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DETAIL 1
LC1 - LC20



9. NETWORKS LC1-LC40 ARE COMPOSED OF 10 pF MONOLITHIC CERAMIC CAPS AND FERRITE BEADS.
8. CAPACITORS C1, C2, C4, C6, C9, C13, C15, C22 ARE 0.1 uF 50V MONOLITHIC CERAMIC.
7. CAPACITORS C3, C7, C8, C14 ARE 47 uF 25V TANTALUM.
6. RESISTORS R1, R10 ARE 100 ohm 1/4W CARBON COMP.
5. RESISTORS R5, R6 ARE 100 ohm 1/4W CARBON COMP.
4. RESISTORS R4, R7, R8 ARE 510 ohm 1/4W CARBON COMP.
3. RESISTORS R2, R3 ARE 470 ohm 1/4W CARBON COMP.
2. RESISTOR R1 IS A 1K ohm 1/4W CARBON COMP.
1. REF 1001325 FOR PCB.

NOTES: UNLESS OTHERWISE SPECIFIED

interface

ASSY/LBO RS-480 DRIVER BOARD

DATE 3-22-80

REV 1

REV 1

REV 1

REV 1

REV 1

REV 1

REV 1

REV 1

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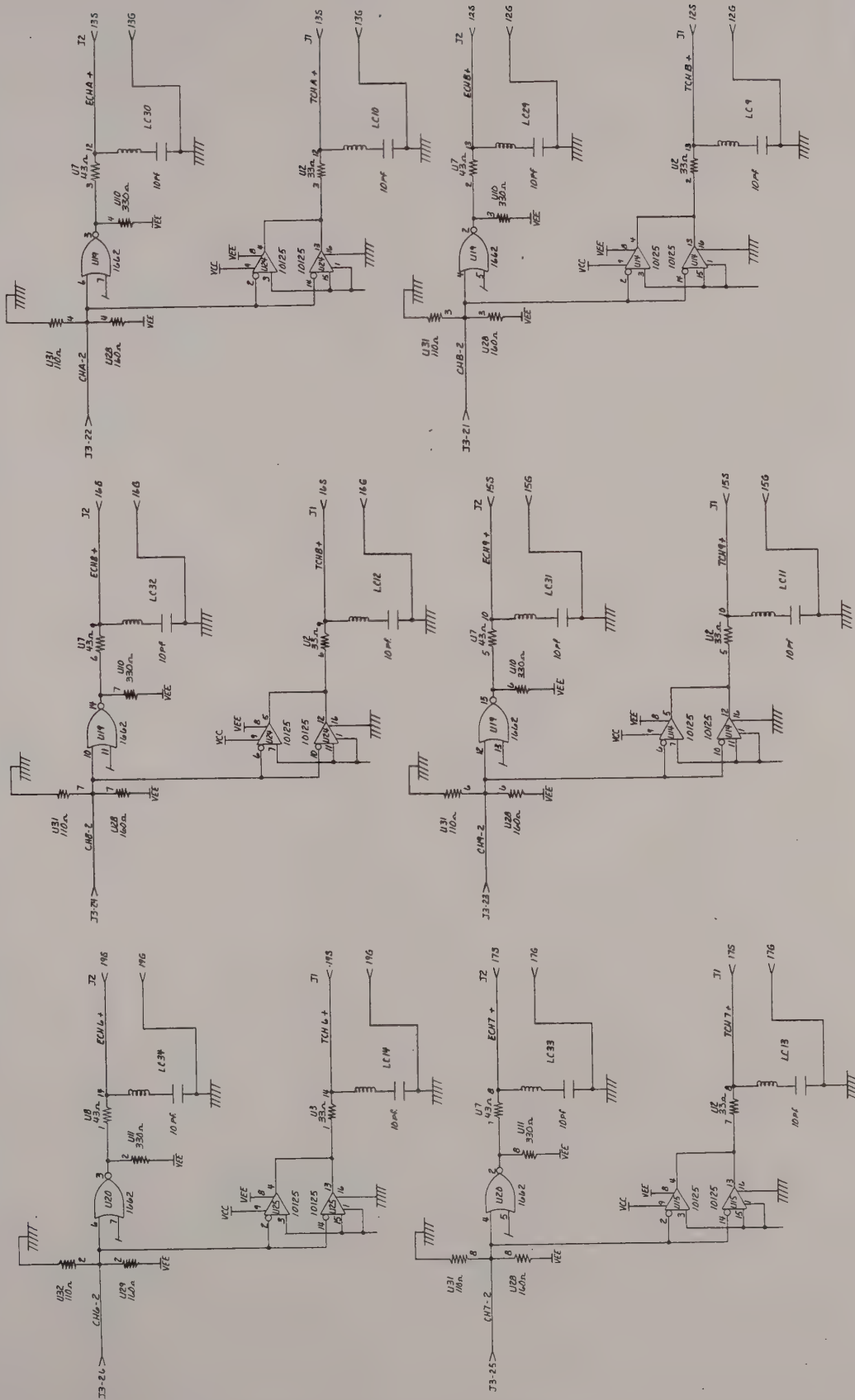
REV 1

REV 1

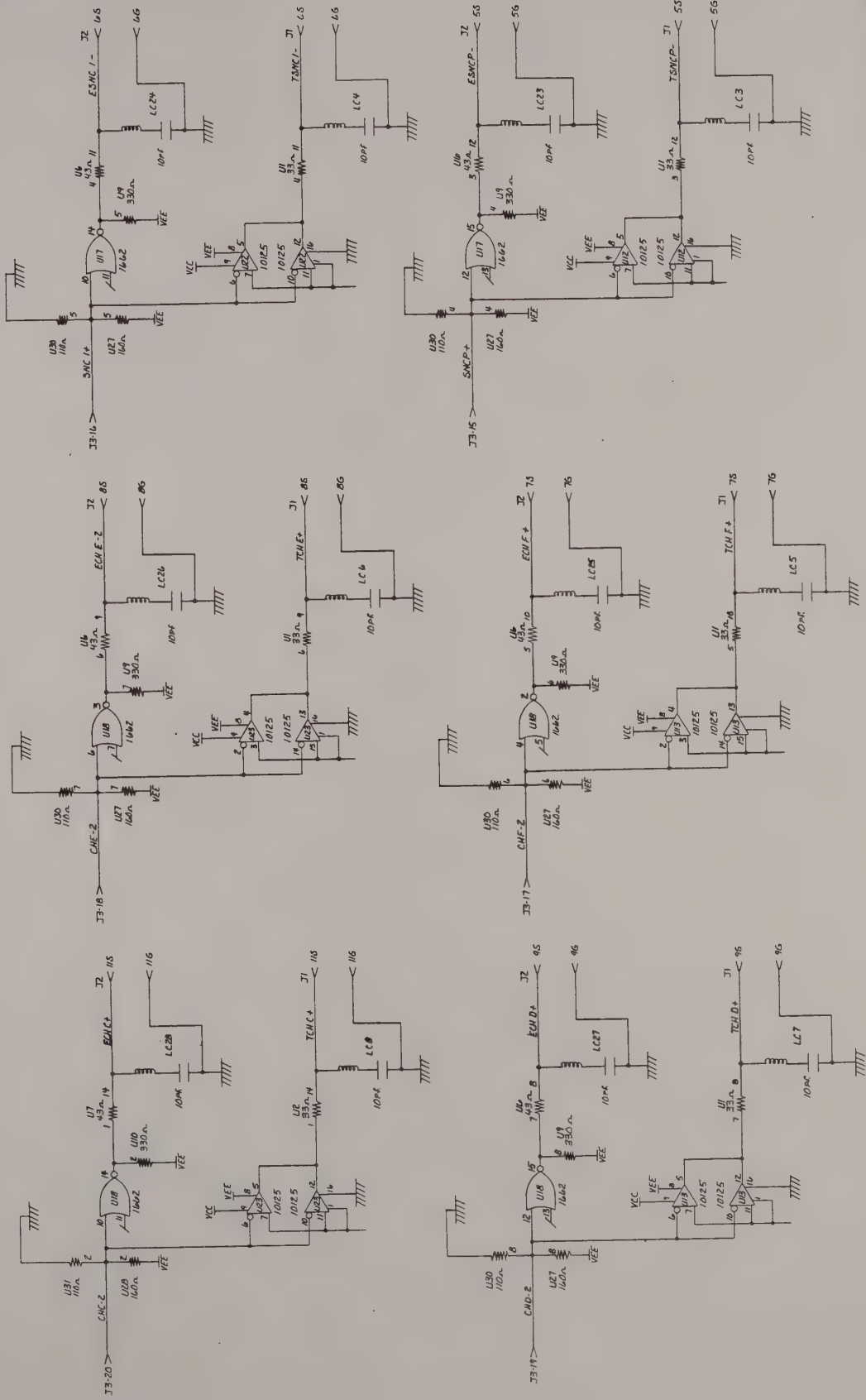
REV 1

REV 1

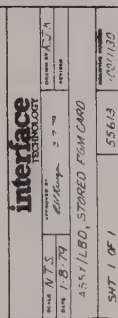
REV 1



Interface			
DESIGNED BY	DATE	REVISED BY	REVISION
ASSY / LBO RS-420 DRIVER BOARD			
SHEET 3	5326/3	100/526	



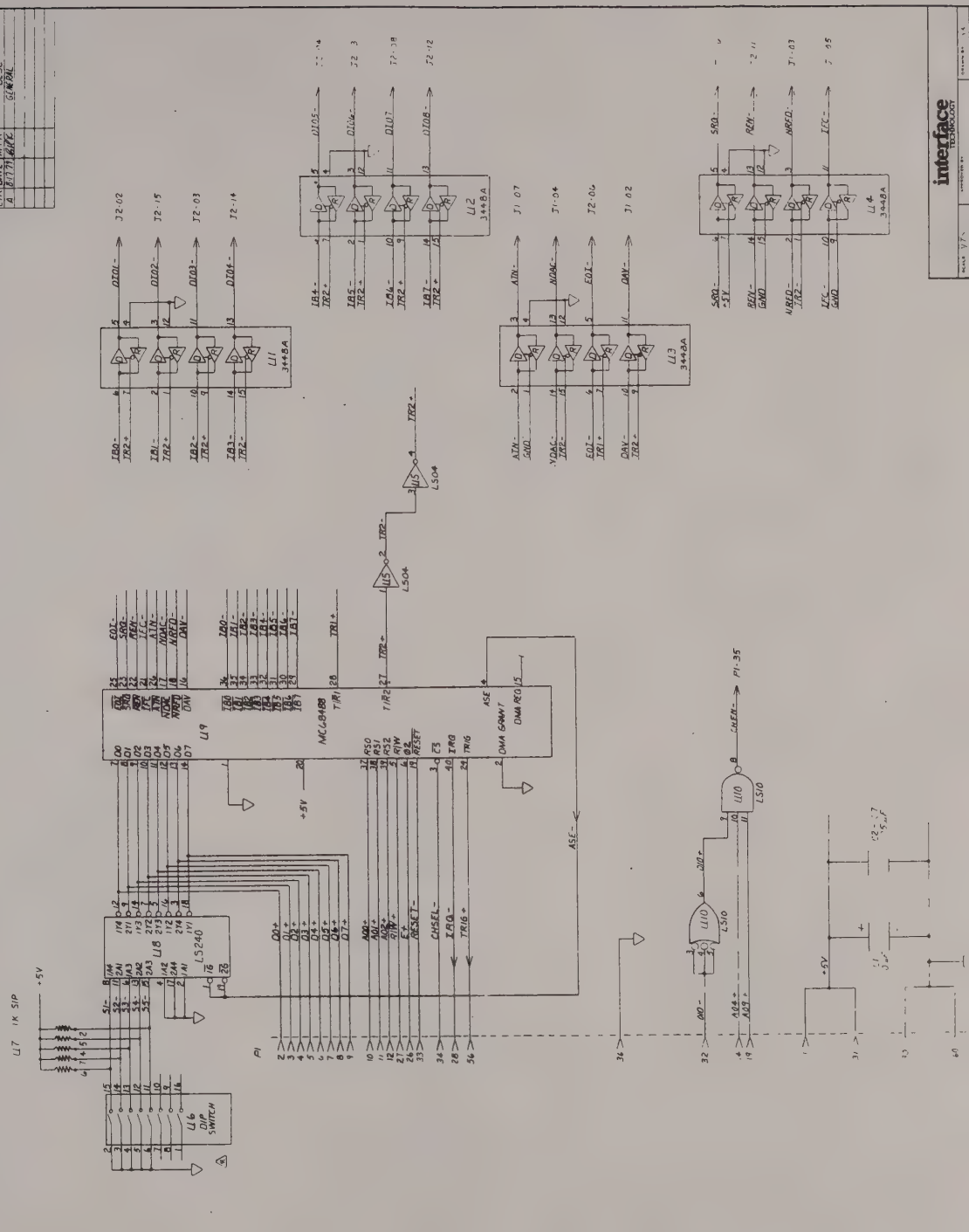
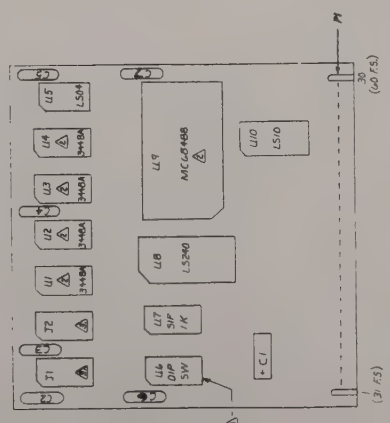
interface		revision 1.0	1001/12/94
part no.	775	ass'y / l80 rs-l80 driver board	556/3
date	10/12/94	shw. 4	1001/12/94



1. U1 - U8 MAY USE INTEL 2758, 2716, 2732 OR 7125/6;
INSTALL FOLLOWING JUMPERS ON U7.

NOTES:

DATE	REV	BY	CHK	APP
10/1/84	1	WJH	WJH	WJH
10/1/84	2	WJH	WJH	WJH
10/1/84	3	WJH	WJH	WJH
10/1/84	4	WJH	WJH	WJH
10/1/84	5	WJH	WJH	WJH
10/1/84	6	WJH	WJH	WJH
10/1/84	7	WJH	WJH	WJH
10/1/84	8	WJH	WJH	WJH
10/1/84	9	WJH	WJH	WJH
10/1/84	10	WJH	WJH	WJH



4. FOR MODEL WITH INTERNAL 5 POSITION DIP SWITCH WITH SWITCH NO. 1 IN SOCKET PHO 2. FOR RS-485 INSTALL CABLE TO REAR PANEL

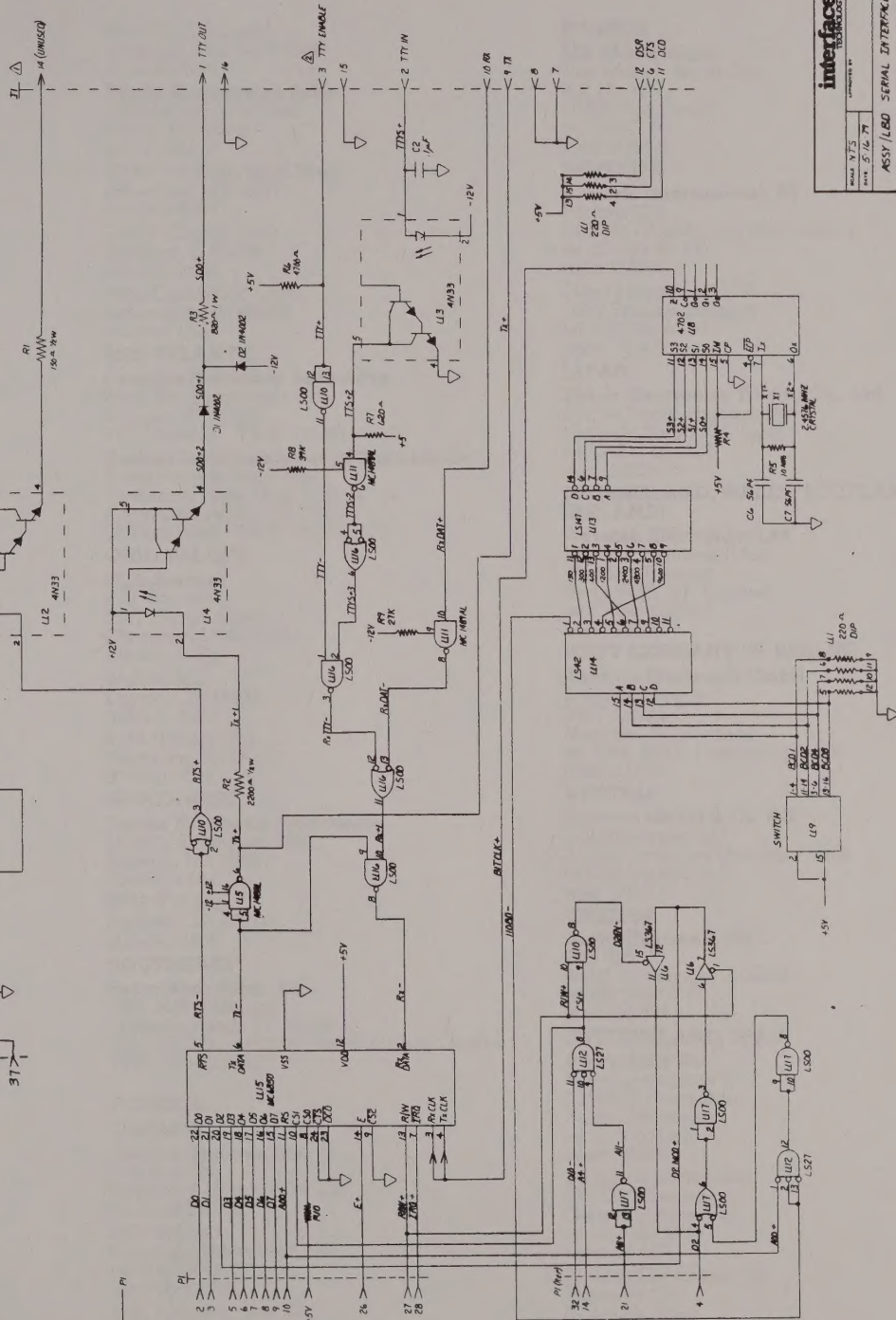
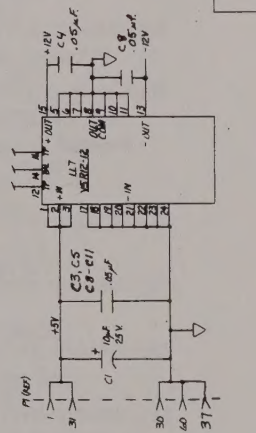
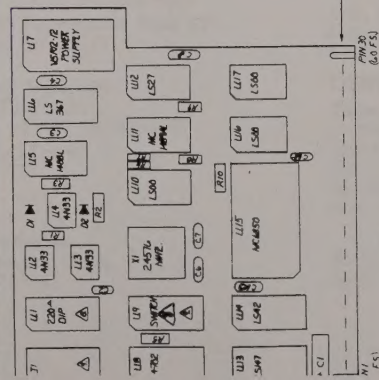
5. W.P. DENOTES HIGH PROFILE SOCKET

6. ALL INTEGRATED CIRCUITS ARE SHOWN UNLESS NOTED

7. REFER TO 1001133 FOR PCB

NOTES: UNLESS OTHERWISE SPECIFIED

interface		DATE: 10/1/84	BY: WJH
REV: 10	APP: WJH	CHK: WJH	APP: WJH
ASSY/LBO IEEE INTERFACE CARD		REV: 10	DATE: 10/1/84

[illegible]

- ⚠️ W.P. DOWRIES HIGH PROFILE SOCKET.
- ⚠️ FOR NO. 10, 10 POSITION ROTARY SWITCH IN L.P. PAN. 10 LOC. FOR RS-500 INSTALL CABLE IN L.P.
- Y ALL INTERMEDIATE CIRCUITS NOT SWITCH UNLESS NOTED
- 6. REF. 1001151 FOR PCB
- ALL RESISTORS ARE 1/4W. W/ CARBON COMP. UNLESS NOTED
- ALL CAPACITORS ARE 0.05F. 25V. CERAMIC UNLESS NOTED
- 3. C1: 5 A 100V 25 WATT ELECTROLYTIC CAPACITOR
- ⚠️ GROUND ON EXTERNAL CABLE TO SWABLE TTY.
- ⚠️ REVERSE CABLE PLUG IN TTY TO OPERATE WITH TTY 20 W/ A REVERSE HALF-COURSET

APPENDIX E REPRESENTATIVES LIST

DOMESTIC

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Ward/Davis Associates

2615 Manhattan Beach Blvd.
Redondo Beach, CA 90278
213-973-7772

2333 Camino Del Rio South, Suite 150
San Diego, CA 92108
714-298-8912

3329 Kufer Road
Santa Clara, CA 95051
408-245-3700

METRO NEW YORK, NORTHERN NEW JERSEY

SET Marketing, Inc.

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Great Neck, NY 11021
516-466-0550 TWX: 510-223-0833

UPSTATE NEW YORK

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315-699-2651 TWX: 710-541-0439
2631 Edgewood Road
Utica, NY 13501
315-732-1801

6780 Pittsford-Palmyra Road
Fairport, NY 14450
716-223-4490

NEW ENGLAND

Pat Jenks Associates

2315 Whitney Avenue
Hamden, CT 06518
203-281-0810 TWX: 710-465-2096
607 North Avenue, Door #16
Wakefield, MA 01880
617-246-1590 TWX: 710-348-6559

ROCKY MOUNTAINS

BFA Corporation of Arizona

12015 East 46th Avenue
Campus Six, Suite 160
Denver, CO 80239
303-371-2422 TWX: 910-932-0315
3705 Westerfield, N.E.
Albuquerque, NM 87111
505-292-1212 TWX: 910-989-1157
P.O. Box 1237
Las Cruces, NM 88001
505-523-0601 TWX: 910-983-0543
4426 N. Saddlebag Trail
Scottsdale, AZ 85251
602-994-5400 TWX: 910-950-1193
140 W. 2100 South, Suite 130
Salt Lake City, UT 84115
801-466-6522 TWX: 910-925-5666

SOUTH CENTRAL

Data Marketing Associates

3330 Bering Drive
Houston, TX 77057
713-780-2511 TWX: 910-881-2569
14235 Proton Road
Dallas, TX 75240
214-661-0300 TWX: 910-860-5483
2401 N.W. 39th Expressway, Suite 103
Oklahoma City, OK 73112
405-528-6071

8622 Crownhill, Suite 105
San Antonio, TX 78009
512-828-0937 TWX: 910-871-1033
300 E. Huntland Drive
Austin, TX 78752
512-451-5174

MIDWEST

Ramsey Associates

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St. Louis, MO 63141
314-569-1406

6900 W. 80th Street
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770 N. Church Road
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312-530-7850

8463 Castlewood Drive
Indianapolis, IN 46250
317-842-1120

MID ATLANTIC

Creative Marketing Associates

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703-893-6612 TWX: 710-833-0310

Eastern Instrumentation of Philadelphia

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215-245-6660 TWX: 510-667-1581

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6520 Milhoff
Dayton, OH 45424
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6145 Hillsboro Rd.
Davisburg, MI 48019
313-961-3042

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Pacific Northwest Electronics

14264 S.E. Eastgate Way
Bellevue, WA 98007
206-641-6444

2035 S.W. 58th
Portland, OR 97221
503-292-3505

SOUTHEAST

Saber Associates, Inc.

2501 N.W. 17th Lane
Pompano Beach, FL 33064
305-973-3804 or 800-327-8998 (Outside Florida)
TWX: 510-956-9477

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2800 Sabourin
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tel: 514-336-0430
telex: 05-825820
2651 Aquitaine, Unit 42
Mississauga, Ontario L5N 1V5
tel: 416-826-7080

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Tage Olsen A/S

Postbus 225
Ballerup BYVEJ 222
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tel: (02) 65 81 11
telex: 35293

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tel: 956-31-30
telex: 695414

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telex: 39564
Huart-Hamoirlaan, 1-7B
1030 Brussels, Belgium
tel: (02) 241-81-30
telex: 25146

JAPAN

Tokyo Electronics Trading Co., Ltd.

307, 4-Chome, Higashifushimi
Hoya-shi, Tokyo 188, Japan
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telex: 2822617

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Wavetek Electronics Ltd.

109 Crockhamwell Road
Woodley, Reading
Berks RG5, 3JP, England
tel: (0734) 694944
telex: 849301

WEST GERMANY (W. BERLIN)

Kontron Elektronik GmbH

Breslauer Strasse 2
8057 Eching B.
Munchen, W. Germany
tel: (089) 31901-1 (central operator)
telex: 522122

AUSTRIA

Kontron GmbH & Co. KG

Industriestrasse B13
A-2345 Brunn am Gebirge, Austria
tel: 022 36/866 31 0
telex: 79337

SWEDEN

Aktiv Elektronik AB

Box 365
S-162 03 Vallingby, Sweden
tel: 08/739 00 45
telex: 08 854-11-436

SWITZERLAND, SPAIN

Instrumatic AG

Weingartenstrasse 9
CH-8803 Ruschlikon
Zurich, Switzerland
tel: 01/724-14-10
telex: 56 605

20, rue de Montchoisy
CH-1207 Geneva
Geneva, Switzerland
tel: 022 36-08-30
telex: 28 667

Avenida Generalísimo 20
Apartado 151
E-Málaga, Spain
tel: 21-31-99
telex: 77-131

Angel Guimera 11
E-San Cugat del Valles
Barcelona, Spain
tel: 674-50-48

interface
TECHNOLOGY

